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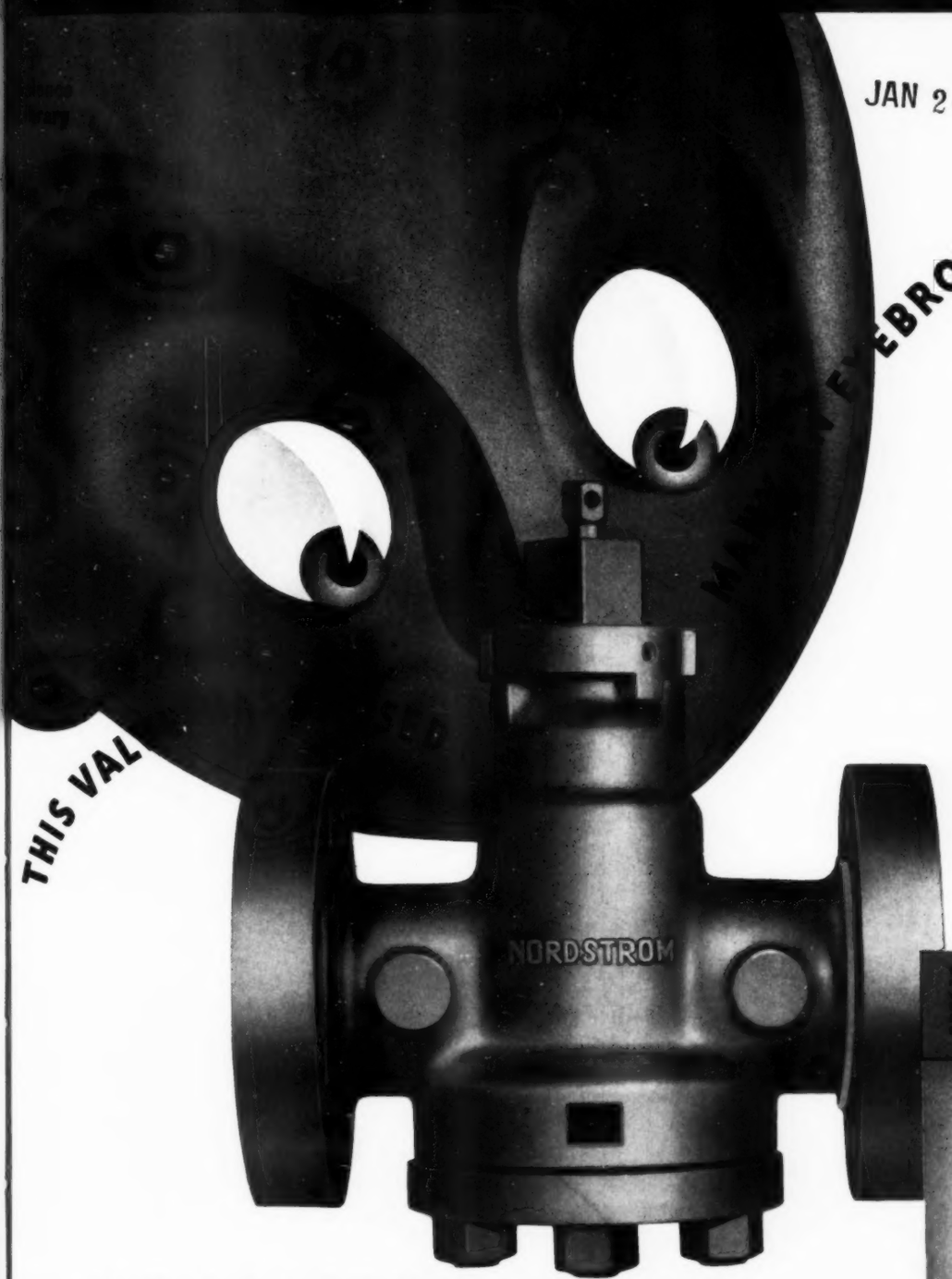

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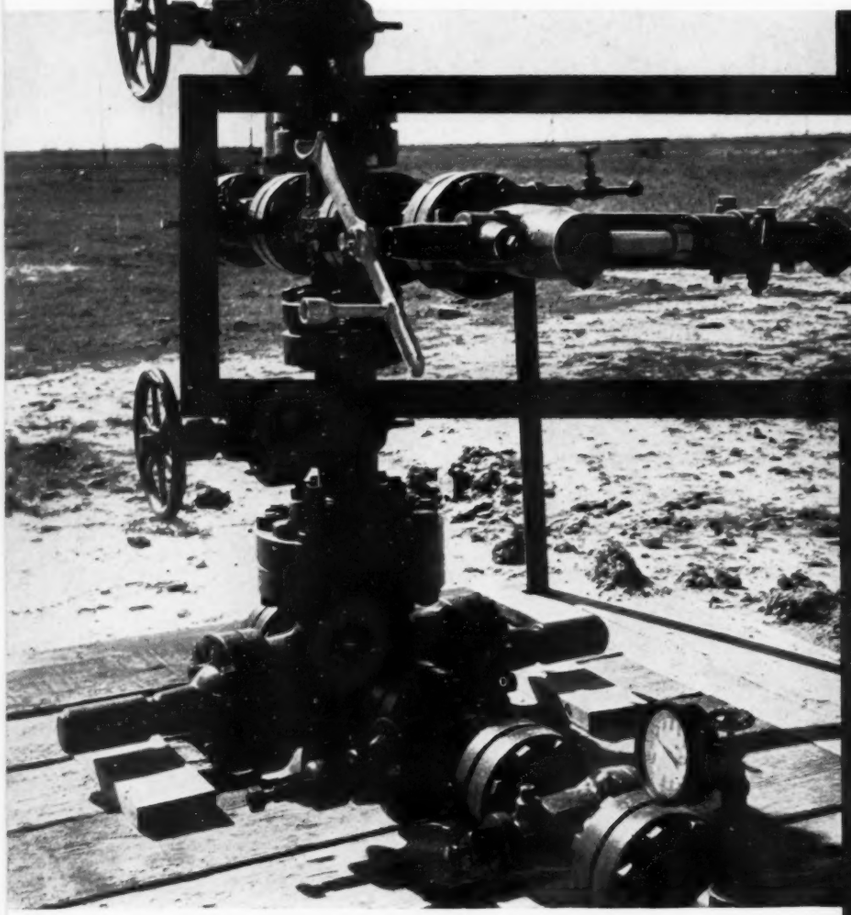

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The new Cameron Type "D" Flow Wing combines in a single unit the double function of a Christmas Tree wing valve and a quick-change positive or adjustable flow bean. The valve section of this unit permits a quick and easily operated shutoff while changing chokes without the necessity of closing any vital valves on the Christmas Tree. The flow bean section of this unit embodies a unique construction which permits the rapid changing of flow bean without breaking out a single threaded connection or removing a flange. All parts of the unit are readily replaceable in the field in a few minutes without removing the assembly from the well.

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Also available as an accessory to the Type "D" Flow Wing is the Cameron Type "GP" Block-off Valve which may be attached to the Flow Wing in event a downstream valve is required for changing chokes. The "GP" Block-off Valve interchanges with the male connection (Part 9, Figure 1) and is clamped to the unit by means of the two-bolt union (Part 8, Figure 1).

When a double wing Christmas Tree is desired, two Type "D" Flow Wings may be fabricated on the side outlets of a flow cross, thus making an extremely efficient and compact upper Christmas Tree section with a minimum of connections.

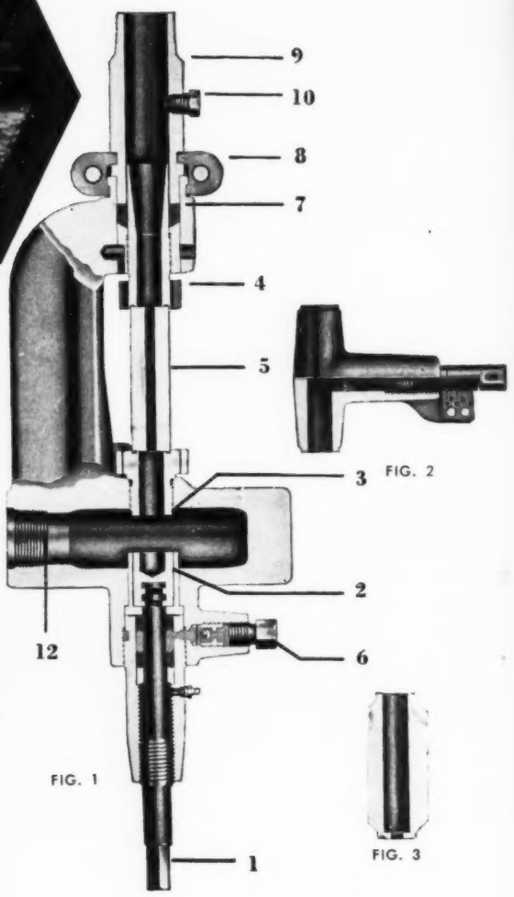

FIG. 1

FIG. 2

FIG. 3

WRENCH

1. Valve Stem; 2. Valve; 3. Valve Seat; 4. Clamp Screw; 5. Flow Bean; 6. Packing Feed Screw; 7. Clamp Screw Packing; 8. Two-bolt Union; 9. Outlet Connection; 10. Bleeder Connection; 12. Inlet Connection.

Referring to Figure 1 above, when it is desired to change a flow bean the hexagon socket in the wrench is fitted to the valve stem (1) and the valve (2) closed against the seat (3). The spanner part of the wrench is then applied to the clamp screw (4), which must be turned only two turns to release the flow bean (5). After installing a new flow bean of the desired orifice size, it is clamped in place by the clamp screw. The valve is then opened and the well is back on production. Both the valve stem and valve seat are faced with hard metal to resist cutting. The valve stem and bonnet are packed with plastic packing which may be replenished under pressure. The clamp screw is packed with an asbestos ring (7) which is tightened automatically as the flow bean is clamped in place. Note that the downstream end of the clamp screw is belled to reduce turbulence and cutting. Three types of flow beans are interchangeable in this unit: (1) the "proration" bean illustrated in the flow wing; (2) the adjustable flow bean illustrated in Figure 2; (3) and the "production" type bean which consists of a body and renewable stellite orifice disc. All of the flow beans clamp in position as shown in Figure 1.

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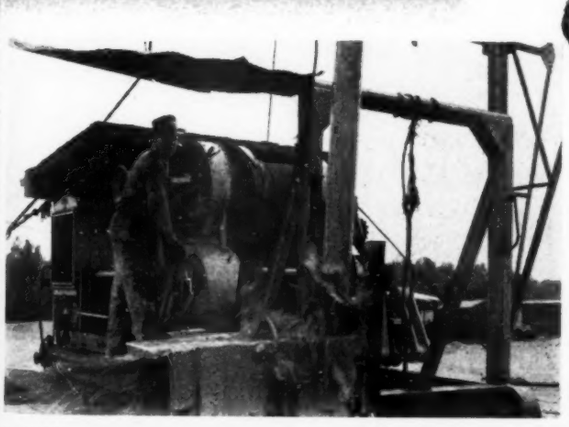
Sincerely yours,
A. B. Ferguson Jr.



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THE Petroleum Engineer

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MEMBER A. B. C.—A. B. P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.)

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The Course of Oil

by K. C. SCLATER

THREE IMPORTANT ORDERS

On January 13, 1942, the anxiously awaited Preference Rating Order P-98 covering all branches of the oil industry was issued. This order, combined with orders P-83 and M-68, presents the main restrictions under which the oil industry must operate "for the duration." Although the greatest care was probably taken in the preparation of these orders, they have given rise to some confusion and many protests; but that was to be expected.

These three orders, P-83, M-68, and P-98, provide priority ratings for every branch of the industry, including suppliers and manufacturers. P-98 provides for obtaining materials for repair, maintenance, and operation in the oil industry, so takes the place of P-100. Order P-83 really governs the incoming flow of materials to supply houses or of raw materials to the manufacturer; P-98 governs the outgoing flow of materials from the supply houses or of fabricated equipment from the manufacturer; M-68 governs the use to which materials are put. Under order P-98 just issued (January 13, 1942), all branches of the oil industry with the exception of marketing are given a blanket priority rating of A-8. Special ratings of A-1-A, A-1-C, A-1-E, and A-2 are also provided for certain materials under certain conditions.

WELL-SPACING RESTRICTION

Order M-68, issued December 23, 1941, restricts the use of material in the production of petroleum. Its purpose is to assure a minimum expenditure of scarce equipment. Certain restrictions included in this order brought protests from operators all over the country. Among the restrictions most loudly protested were the 40-acre spacing rule for oil wells and the status of operations in progress on December 23, the date the order was issued. An amendment has since been issued exempting drilling operations in progress on that date, but the spacing order of 40 acres for oil wells remains. No departure from the restriction will be allowed unless valid justification for exception exists.

Restriction of one well to 40 acres may seem quite drastic, but when supplementary orders PD-214a and PD-214b for making applications for exemption from the spacing rule are considered, the restriction is not quite so drastic as it seems. Closer well spacing will be granted should requests be supported and justified by field data. Perhaps many of the protests can be traced to the amount and nature of the information requested in the application for exemption under PD-214b. An independent operator who does not have a large field organization may not have available the detailed field data requested and so would feel he was at a disadvantage in making application for closer spacing. Should the property of a small operator, however, be in a field in which a number of large operators have an interest, the application for exemption would be made on form PD-214a. This is the form to be used when a well-spacing exception for the whole field is applied for. In that case, all companies in the field may pool their information on reservoir and field operating conditions in making application for an exemption under this order. This might be considered less onerous by the small independent operator.

Inclusion of a 40-acre spacing puts the burden of justifying closer spacing on the operators themselves. Some hardships will result from this seemingly drastic provision. It may take some time to obtain the necessary data that will justify closer spacing; in that case some delay to development might result. There is reason to believe, however, that the OPC will grant without undue delay applications for exception from the 40-acre spacing should the field data justify it. A wildcat well may disclose a prolific sand having good oil saturation and of abnormal thickness and areal extent; in that case the field data would be ample to support an application for closer spacing.

In a pool that has several separate producing sands, dual or multiple completion of wells might be practicable. Granting of exceptions to well-spacing in such a pool would depend on whether a more economical use of steel per unit volume of production could be obtained by dual or multiple completions or by closer spacing.

The Petroleum Coördinator's Office is well fortified with the experience and advice of competent oil men, who are engaged in the task of putting into practice the best available methods that will lead to the economical use of materials and efficient development of new fields, and also the prudent maintenance of production in existing fields in the present emergency.

If the producing branch of the industry adheres to good conservation practices, they can be assured of the support of PCO officials. Many of our present field practices could be improved on by a fuller recognition and appreciation of reservoir conditions. The advantages now gained at great sacrifice may prove to be of lasting benefit to the oil industry.

Some means of controlling the number of wells and limitation of some sort on the use of materials is believed to be under serious consideration. It is evident that unless some sort of control is exercised, wildcat drilling may lead to excessive use of essential materials. Permits sanctioning the drilling of wildcat, or exploratory, wells may become necessary. To decide on which wildcat or exploratory project should have a preference —if it became necessary to make such a decision— would pose a delicate and difficult problem.

In the final analysis, the national scarcity of steel and other essential materials for war needs requires that the oil industry and every employee connected therewith see to it that these essential critical materials are so used that the greatest quantity of petroleum and its products be produced with the least jeopardy to our known reserves of this vital national resource and without impairing present field or plant operations.

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Highlights IN OILDOM

Intangible Drilling Cost Ruling Reversed

The U. S. Bureau of Internal Revenue has ruled that individuals or companies may charge off intangibles (expenses) incurred in the drilling of oil and gas wells under contract, reversing the policy that had been announced by Commissioner of Internal Revenue Guy T. Helvering after the United States Board of Tax Appeals had recognized a new principle in a Texas decision.

The Board of Tax Appeals had held that no deductions could be allowed except in cases where the drilling was done by the individual or company claiming the deduction. Such a policy placed the drilling contractor at such a disadvantage that he could no longer drill for companies charging off intangibles in drilling operations.

A committee from the American Association of Oilwell Drilling Contractors conferred with Bureau heads in Washington on November 3, 1941, and obtained assurances of a delay in enforcing the ruling that would have necessitated capitalization of intangibles. This committee was composed of J. E. Brantly, president; W. D. McBee, assistant to the president; Harold F. Thompson, attorney for the association, and Will I. Lewis, a director.

Ickes Urges Illinois Conservation Law

Petroleum Coördinator for National Defense Harold L. Ickes recently announced that he had addressed a message to Governor Dwight H. Green of Illinois suggesting that the latter ask the Illinois legislature to enact a petroleum conservation law if a special session is conducted.

The text of Ickes' telegram to the Governor follows:

"I understand that you propose to call a special session of the Legislature to deal with defense problems. If you do, I strongly recommend that it be asked to enact a conservation law with respect to petroleum. There is no item in our whole national economy that is of more importance in the matter of defense than oil, and the wasteful production of it is something that all good citizens should combine to prevent.

"Illinois is generally regarded by oil authorities as being one of the few oil producing States where production of oil has been carried on in a manner permitting waste. A number of unsuccessful efforts have been made to enact a conservation law deemed effective."

Japan's Petroleum Resources

As in the case of Germany, whose petroleum resources have been the subject of many articles, a question immediately raised by the war with Japan is that of the petroleum resources of that nation, says a release of The Independent Petroleum Association of America. Naturally, little has been revealed by Japan in recent months concerning her supply, but the assumption can safely be made that Japan must by conquest of arms acquire petroleum stores and oil fields or face steadily decreasing supply. Her present storage is an unknown factor. What is known is that the current supply from fields now in her possession is small.

Within the Japanese Empire including the island of Taiwan, or Formosa, are some small fields. The total production for 1940, according to the U. S. Bureau of Mines, was 2,639,000 bbl. To the north is the island of Sakhalin, the north half of which is owned by Russia and the south half by Japan. Principal oil production on this island is in the Russian-owned part, but the fields are operated by a Japanese concessionaire under an agreement made long ago. The oil production of Sakhalin in 1940 was estimated by the Bureau of Mines as 4,000,000 bbl. It is unlikely, in view of what is known of the potentialities of fields controlled by Japan, that the production has been increased over the 1940 figure. It had varied little over a five-year period—less than one million barrels gain in 1940 against the total for 1936. The fields are old and little new discovery has been made in years.

The oil production owned by Japan, therefore, is far below the needs. An estimate by a group of authorities early last year published in the annual petroleum volume of the American Institute of Mining and Metallurgical Engineers was that exclusive of military uses Japan consumed 26,000,000 bbl. of petroleum and substitutes in 1940. Some other authorities raise this to 40,000,000 bbl. annually by estimating military needs.

Japan produces and uses certain gasoline substitutes, alcohol and coal derivatives. It was estimated that the 1940 production of these fuels was 4,500,000 bbl. Adding that quantity to the combined production of crude oil from fields of Japan and Sakhalin Island the total is 10,539,000 bbl.—approximately one-fourth the estimated annual needs.

It is considered to be likely that Japan's production of synthetic fuels has been increased this year, as there have been reports of new plant construction to make motor fuel from coal, but it is not probable that such increase has been sufficient to alter the ratio of supply to needs in view of the greatly expanded war uses.

Japan has always been an importer of petroleum. Supplies came from the Dutch East Indies and the United States. Shipments from the United States ceased last July and little if any oil has been exported to Japan by the Dutch East Indies for some weeks.

During this period of no imports it is obvious that there has been no opportunity to increase stores of motor fuel and other petroleum products in Japan. The assumption is that heavy drawing on the storage must have been going on.

Oil production available to the United States and her allies in this theatre of the war is substantial. Production from the Dutch East Indies totaled 60,830,000 bbl. in 1940 and that from British fields in the East Indies was 7,047,000 bbl. Included in available petroleum in this area is that of Burma, 7,979,000 bbl., and of India, 2,250,000 bbl., all 1940 figures. The total from British and Dutch possessions in this part of the world was 78,110,000 bbl. for the year.

Australia and New Zealand have negligible production of oil, none is produced in the Philippine Islands.

Foreign Nationals Must Report Property

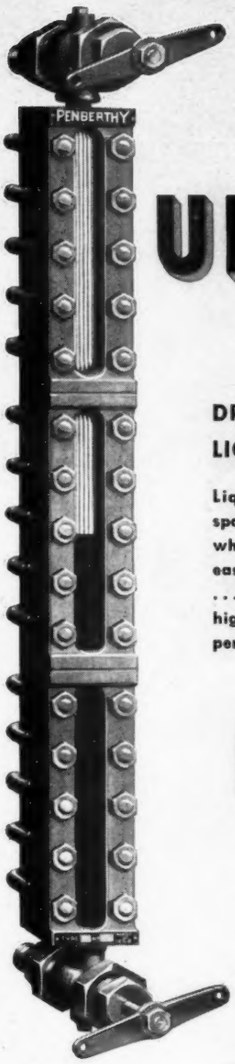
Oil and gas interests owned by foreign nationals whether of enemy or friendly nations must be reported to the U. S. Treasury Department by January 31, according to final instructions from Washington, D. C.

According to the instructions of the treasury department, the lessee under a non-producing oil and gas lease must report any share of the royalty or mineral interest owned by a foreign national either as an original party or by assignment.

No report need be made if the total value of all property is less than $1000. All reports have to be made under affidavit, but 100 may be sworn to under a single affidavit. Operators of pipe lines need not report oil belonging to a national that was only in temporary custody solely for transportation. Oil stored, however, must be reported.

Blanks on which to report may be obtained from Federal Reserve Banks, and are designated as Form TFR-300.

Operators with oil interests in other nations also must report these to the treasury department.



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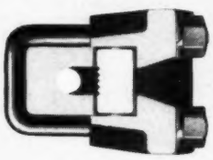

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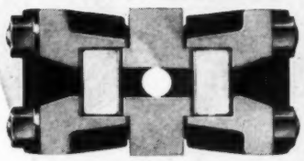
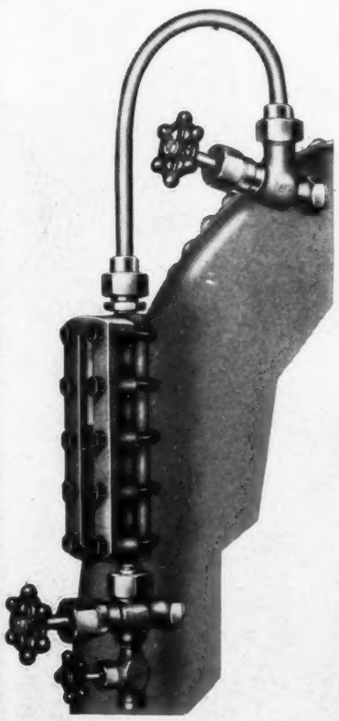


Penberthy Liquid Level Gages



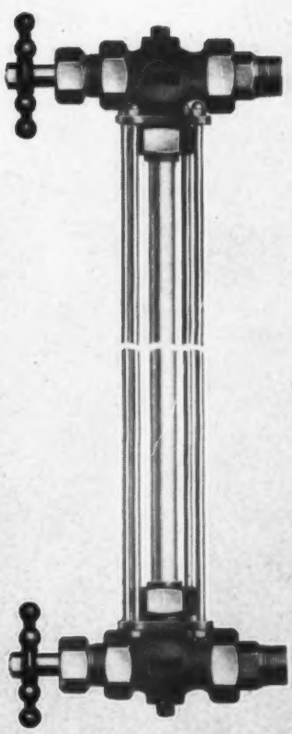
ALL PENBERTHY GAGES
CONFORM WITH A. P. I.—A. S. M. E. REQUIREMENTS

PENBERTHY
Reflex
WATER GAGE SET

Water shows black—steam shows white. U-bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.

PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES

Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.



PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN — Canadian Plant: Windsor, Ontario

PENBERTHY PRODUCTS

MAJOR *Refining* ACTIVITIES

Percent Refining Capacity Operated

Western Division, 72.8 Percent **Central Division, 99.9 Percent** **Eastern Division, 95.5 Percent**

THE Lone Star Gas Company has placed on stream the newest cycling plant for the East Texas district. Their plant, situated in the Willow Springs field in Gregg County, cost approximately $400,000.

Assignment of a high preference rating by special order issued by the director of priorities has assured obtainance of materials to be used in the operation of a British refinery for aviation gasoline, situated in the Caribbean area. The rating was granted to The Anglo-American Purchasing Company to obtain a specified list of materials.

To avoid the necessity of handling many individual applications for the requirements of the refinery, which includes a large number of diverse items, a single order has been issued covering all the materials.

More than $3,000,000 will be invested by Stanolind Oil and Gas Company, Humble Oil and Refining Company, and Humble Pipe Line Company in the construction of the world's largest gas cycling plant in the Katy gas field of Waller, County, Texas. The plant will process 274,000,000 cu. ft. of gas per day. According to an announcement from the Office of Petroleum Coördinator for National Defense, a preference rating of A-1-a was assigned to the project to insure swift construction. Construction of the plant is being undertaken as a major step in the program to boost production of 100-octane aviation gasoline.

Processing of the large quantities of natural gas will yield nearly 7500 bbl. per day of combined distillate, kerosine, naphtha, natural gasoline, butane, and *iso*butane. The most economical amounts of *iso*butane and butane, essential to the manufacture of 100-octane aviation gasoline, will be extracted by the plant.

The high priority rating not only covers the plant proper, but materials and equipment for the drilling of eight additional gas wells and for the construction of 4-in. gasoline pipe line, 46 miles in length.

Completely unitized, the Katy field will be operated conservatively on a basis of less than 3 percent yearly withdrawal of available condensate and butane. The residue gas will be returned to the producing formations for pressure maintenance of the field. Ultimate recovery by the plant of the 102,000,000 cu. ft. of cendensate and butane reserves estimated in place, is expected to be 75 percent.

The extractions of butanes and *iso*butanes by the plant will be valuable additions to the stocks of components for the manufacture of 100-octane aviation gasoline. One of the major items in the comprehensive program of the Petroleum Coördinator is the increased extraction of such components of 100-octane aviation gasoline, which yields 25 percent more power for military planes, and is used in the air fleets of the United States and its Allies.

The Talco Asphalt and Refining Company plant at Mount Pleasant, Texas, and the Talco Pipe Line Company line supplying the refinery have been purchased by Clint Murchison and associates of Dallas, Texas, for approximately $1,000,000.

Murchison and his associates had formerly owned half of the plant and obtained the remaining half from the Lucey Petroleum Company of Dallas and Ralph E. Fair of San Antonio, Texas.

In operation for the last 5 years, the plant has a capacity of 10,000 bbl. per day. The pipe line purchased consists of 50 miles of main line between the Talco and Sulphur Bluff fields and about 60 miles of gathering lines.

The Lummus Company of New York, New York, will begin construction March 1 of a new aviation gasoline unit for the Gulf Oil Corporation at Port Arthur, Texas. Addition of the new unit, costing $3,000,000, will double the capacity of the plant for the production of 100-octane aviation gasoline, bringing the total output to approximately 4000 bbl. per day.

An increase in production of the Bolivar, Pennsylvania, plant of Allegany Refineries, Inc., is being made possible by the addition of a new still and other equipment. The new still will permit processing of 250 bbl. of oil per 36 hours. Additions to the plant are about half completed.

Announcement has been made by The Bell Oil and Gas Company of Tulsa, Oklahoma, of their purchase of the Malco Refineries, Inc., of Artesia, New Mexico. Included in the purchase are the modern refineries at Grandfield and Ardmore in southern Oklahoma and a skimming plant at Artesia. Purchase of the plants gives the company facilities to serve the middlewest and southwestern consumers. Equipment of the Malco company consists of a Dubbs cracking unit with the uniflow furnace, a Perco copper treater, a Phillips catalytic desulphurizing unit, and a Gray gasoline treating unit.

Capacity of the Artesia skimming plant is rated at 2500 bbl. per day and the cracking capacity at 1200 bbl. Crude oil for the refinery is taken from nearby Maljamar and Artesia fields.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended December 27, 1941
A.P.I. Figures

(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	653	92.8	20,040	31,382
Appalachian	84.1	136	95.1	3,430	1,100
Ind., Ill., Ky.	84.7	643	98.5	16,689	9,618
Okla., Kans., Mo.	81.1	315	92.9	8,427	3,934
Inland Texas	64.9	137	79.7	2,552	1,676
Texas Gulf Coast	91.2	1,050	103.0	14,184	15,235
Louisiana Gulf	94.8	155	95.1	3,165	3,978
No. La. and Ark.	51.5	46	92.0	423	621
Rocky Mountain	50.4	51	73.9	1,250	491
California	90.9	520	72.7	15,844	75,702
Reported	86.8	3,706	92.0	86,004	133,737
Estimated Unreported		390		5,475	2,675
*EST'D TOTAL U. S. DEC. 27, 1941		4,096		(a)91,479	146,412
*EST'D TOTAL U. S. DEC. 20, 1941		4,070		89,297	147,047
U. S. B. of M. *DEC. 28, 1940		3,582		83,281	143,154

*Estimated U. S. Bureau of Mines' basis.
(a)Finished 83,630,000 bbl.; unfinished 7,849,000 bbl.

PRESSURE STORAGE TANKS Protect Volatiles at Recycling Plants

THE problem of preventing costly evaporation losses from the storage of volatile petroleum products produced at modern recycling plants is being solved efficiently and economically at many plants through the use of pressure storage tanks. These include Hortonspheres, Hortonspheroids, and Hemispheroids, as well as horizontal and vertical bullets.

In appearance, all of these tank types are quite dissimilar, but they all have one important feature in common—the ability to protect their volatile contents against vapor loss. This protection is accomplished by making use of the simple fact that no loss will occur as long as vapor does not escape from the tank. Thus, pressure storage units are built to withstand the maximum vapor pressure of the product being stored and are equipped with relief vents set to open above this pressure. Instead of allowing the air-vapor mixture to escape when the temperature rises, pressure is built up inside the tank.

The four Hemispheroids shown above represent one example of the way in which pressure storage is being utilized at recycling plants. Two of these units have a capacity of 20,000-bbls. each, and the others a capacity of 10,000-bbls. each. They are installed at the well-known Cotton Valley, Louisiana, plant, and are used for the storage of gasoline at a working pressure of five pounds per square inch.

Hemispheroids are built in capacities of 2,000 to 30,000-bbls. for pressures of 2½ to 5 lbs. per sq. in. For sizes up to 120,000 bbls., and pressures up to 30 lbs., or more, the spheroidal type is used. Hortonspheres are built in capacities of 1,000 to 20,000 bbls. for pressures up to 100 lbs. per sq. in., or more, particularly in the smaller sizes.

CHICAGO BRIDGE & IRON COMPANY

HOUSTON . . . . . 5637 Clinton Drive
TULSA . . . . . 1634 Hunt Bldg.
BIRMINGHAM . . . . 1570 N. 50th Street
HAVANA . . . . . 402 Edificio Abreu
CHICAGO . . . . 2481 McCormick Bldg.
DETROIT . . . . . 1538 Lafayette Bldg.
CLEVELAND . . 2251 Builder's Exchange
PHILADELPHIA . . 1635-1700 Walnut St.
NEW YORK . . 3373-165 Broadway Bldg.
WASHINGTON . . 811 Washington Bldg.
SAN FRANCISCO . . . 1064 Rialto Bldg.
LOS ANGELES . . . 1446 Wm. Fox Bldg.

Fabricating Plants in BIRMINGHAM, CHICAGO and GREENVILLE, PA.

MAJOR *Oil Field* ACTIVITIES

A NEW oil field has been discovered in North Texas 6 miles south of Albany, Texas, by R. H. Roark No. 2-A J. H. and R. B. Elliott, in block 9, southern Shackelford County.

Completed in the Strawn sand, the well flowed by heads after cleaning from a 100-quart shot at 2902-40 ft. Contractors for the well, Groover and Rose, have estimated the well's production at 300 bbl. of high-gravity crude oil per day.

Considered one of the most important discoveries in the county in several years, the well when drilled through the Strawn sand earlier showed for approximately 100 bbl. of oil per day, natural flow. Drilling continued to test the Marble Falls formation from 4115-16. The 1 ft. of sand had an estimated 2,000,000 cu. ft. of gas per day flow. Deepening to the Ellenburger, lower Ordovician lime encountered at 4367 ft. found water. Roark No. 2-A Elliott, located about a quarter-mile to the east, was completed in the Strawn at 2845 ft. for 6,900,000 cu. ft. of wet gas per day.

Barnsdall Oil Company's major discovery, Edgar Bond No. 1, section 11-15s-24w, 15 miles northwest of the Buckner field, LaFayette County, Arkansas, logged 215 ft. of saturated Smackover lime, said to be the greatest amount of such saturation yet logged in the state in that formation. The test logged saturation from 6300-6515 ft. after drilling to 6537 ft. The top of the Smackover lime was found at 6290 ft. with 20 percent porosity and good permeability. Cores from the test showed 38-gravity oil. Initial flow of the well was from 110 perforations at 6340-70 ft. Flow was through a 3/16-in. choke and was 15 bbl. per hour. Tubing pressure was 575 lb. and casing pressure 100 lb. Pipe was set at 6487 ft. Flow at capacity was estimated at from 10,000 to 15,000 bbl. per day.

The Port Barre field in St. Landry Parish, Louisiana, has a new deep sand found by the Pan-American Production Company, who completed Garland No. 12 on the southwest flank of the dome. The well made 342 bbl. of 36.5-gravity oil per 24 hours on a 10/64-in. choke from casing perforations at 6638-60 ft. Tubing pressure was 1150 lb. with a gas-oil ratio of 257 to 1. The well was bottomed in salt at a total depth of 6962 ft. Oil sands were logged at 5798 to 6046 ft., 6060 to 6070 ft., 6274 to 6285 ft., 6387 to 6403 ft., 6432 to 6438 ft., and 6482 to 6502 ft.

The Barada pool of Richardson County, Nebraska, has been given a north extension by The Skelly Oil Company well Roesch No. 5, CW½ NW NW of 36-3n-16e. The hole filled with oil in slightly less than 20 hours after the operator had drilled into the Hunton lime, which was topped at 2385 ft.

The Trees Oil Company apparently has opened a new oil pool with its Deichman No. 1, a wildcat in NW NW SW of 21-31-4e, about 3 miles south of the David (Bartlesville) pool in Cowley County, Kansas, and 2 miles east of the prolific Hittle (Arbuckle) pool.

After penetrating the Bartlesville sand 1 ft. at 2835 ft. the well was reported to have flowed 200 bbl. per day.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	.88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.94-1.48
Coalinga	.73-1.13	North Louisiana	1.20-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	.96-1.20		
New Mexico	.70-1.15	Indiana	1.22
Texas		Ohio	
North Central	.78-1.18	Lima	1.17
Panhandle	.70-1.12		
West Texas	.70-1.12	Michigan	1.24-1.44
Gulf Coast	.93-1.48		
Darst Creek	1.14	Pennsylvania	
East Texas	.80-1.27	Bradford	2.75
Talco	.79	Southwest	2.40
Kansas	.85-1.25	Eureka	2.34
Oklahoma	.75-1.25	Buckeye	2.30
Arkansas	.94-1.30	Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.

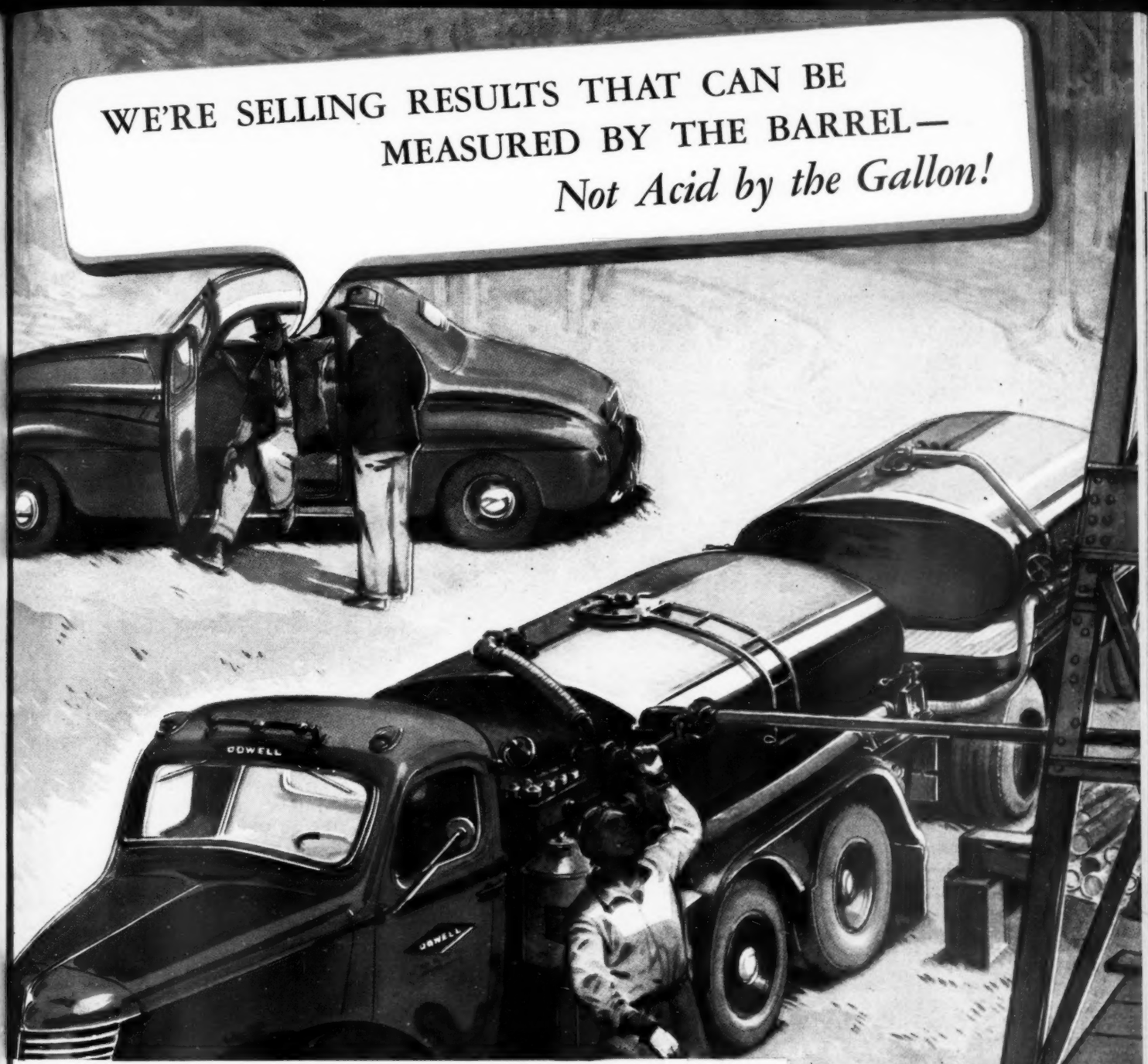
(Figures in bbl. of 42 gal. each)

	[1]B. of M. Calculated Requirements (December)	Week Ended Dec. 27, 1941	Week Ended Nov. 29, 1941	Week Ended Dec. 28, 1940
Oklahoma	460,000	[2]419,650	425,100	399,750
Kansas	260,700	[2]256,650	249,200	186,350
Nebraska	6,100	[2]5,350	5,800	2,550
Panhandle Texas	.....	88,050	85,100	71,400
North Texas	.....	108,000	107,050	97,550
West Central Texas	.....	31,300	30,950	30,600
West Texas	.....	291,600	286,500	181,600
East Central Texas	.....	86,850	86,100	80,050
East Texas	.....	369,100	369,500	301,350
Southwest Texas	.....	216,200	216,250	162,000
Coastal Texas	.....	292,250	291,200	212,050
TOTAL TEXAS	1,479,700	1,483,350	1,472,650	1,136,600
North Louisiana	.....	82,200	81,600	67,950
Coastal Louisiana	.....	277,800	266,850	220,550
TOTAL LA.	340,000	360,000	348,450	288,500
Arkansas	76,500	73,500	74,050	68,500
Mississippi	60,300	[2]73,150	74,450	15,050
Illinois	426,500	393,400	400,300	336,900
Indiana	19,700	[2]19,950	18,400	20,550
Eastern (not incl. Ill. and Ind.)	96,900	89,550	96,250	89,550
Michigan	52,300	56,800	56,950	42,150
Wyoming	81,900	86,000	82,050	73,400
Montana	20,700	22,600	21,400	18,200
Colorado	5,800	5,350	5,350	3,450
New Mexico	116,100	118,850	117,800	101,400
TOTAL EAST OF CALIF.	3,503,200	3,464,150	3,448,200	2,782,900
California	635,800	616,700	638,400	602,600
TOTAL U. S.	4,139,000	4,080,850	4,086,600	3,385,500

[1]These are U. S. Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of December. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

[2]Oklahoma, Kansas, Nebraska, Mississippi, and Indiana figures are for week ended 7 a. m. December 24.

WE'RE SELLING RESULTS THAT CAN BE MEASURED BY THE BARREL— *Not Acid by the Gallon!*



"OURS IS A SERVICE BUSINESS designed to produce results. . . . That's what you pay for and that's what you get. The sale of acid always has been and always will be of secondary concern to us.

"We've built a business of international importance on this basis. . . . Dowell chemical service for oil and gas wells is available in all the important producing areas of the United States, Canada and Mexico.

"So if you are in the market for results that can be measured by the barrel, rather than for acid by the gallon, we'd like to talk to you."

DOWELL INCORPORATED

Executive Office:
MIDLAND, MICHIGAN
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KENNEDY BUILDING
TULSA, OKLAHOMA

Subsidiary of The Dow Chemical Company

Look to
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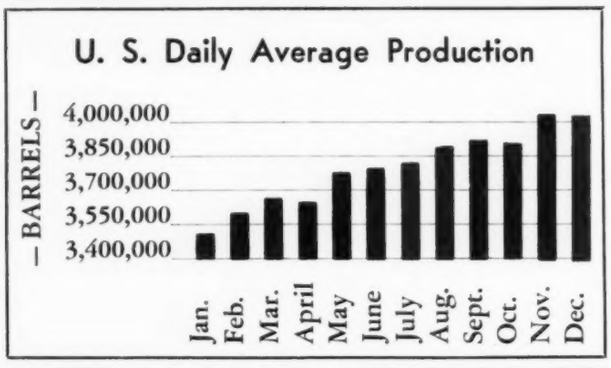
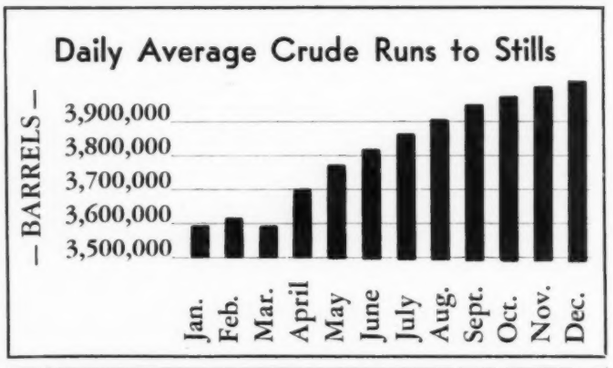
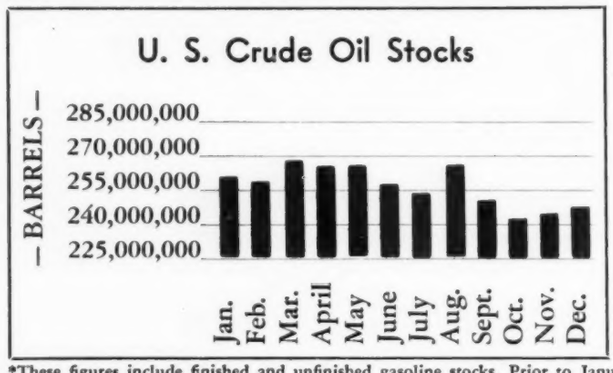
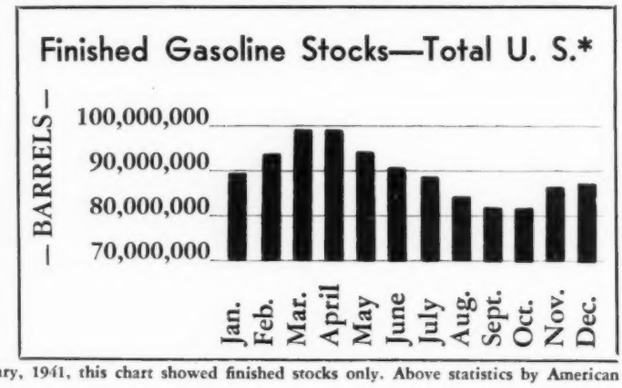
FOR OIL AND GAS WELL CHEMICAL SERVICE

PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for December, 1941

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	61	48	10	27	3500-3700	2	40	Rotary
Gaines County	10	10	5	11	4400-5584	2	22-35	Rotary
Hockley County	52	52	9	17	4800-6850	2	20-30	Rotary
Ector County	25	24	7	22	3675-4377	2 or 3	32-36	Rotary
Panhandle	66	65	11	25	1700-3900	2	40	Rot.-Cab.
Nueces County	18	15	4	18	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	21	17	5	13	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	22	20	4	14	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	10	7	6	7	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	19	15	7	6	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	17	13	8	12	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	21	12	8	10	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	284	217	319	194	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	13	12	7	6	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	35	33	10	4	1840-11,450	3 or 4	14-30	Rotary
Wilmington	17	17	5	3	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for December, 1941

State	Completions December	Completions November	Producers December	Producers November	Locations December	Locations November	Rigs December	Rigs November	Drilling Wells December	Drilling Wells November	Production, 1940 (In Barrels)
Arkansas	6	17	5	13	11	14	8	10	8	13	25,699,000
California	102	101	94	92	86	57	78	78	44	80	224,029,000
Colorado	3	3	1	2	3	1	2	3	1	1	1,369,788
Illinois	284	337	217	266	382	406	319	365	194	180	146,572,938
Indiana	46	46	31	26	63	55	20	20	47	53	4,946,384
Kansas	149	132	114	86	193	190	21	18	135	140	65,602,452
Kentucky	27	34	19	20	38	39	6	8	21	25	5,282,335
Louisiana	115	136	81	91	138	110	55	52	136	195	103,738,728
Michigan	92	86	65	67	131	94	25	25	85	76	19,768,984
Mississippi	6	8	4	6	....	....	....	....	....	....	4,313,158
Montana	41	29	30	22	23	19	14	10	25	15	6,663,872
Nebraska	5	9	4	5	6	8	4	6	4	6	267,533
New Mexico	39	43	32	35	33	45	16	18	28	39	38,893,898
New York	137	135*	137	65*	....	....	....	....	....	....	4,240,441
Ohio	108	162	56	121	....	....	....	....	....	....	3,132,280
Oklahoma	170	126	119	84	171	186	19	17	128	110	152,516,049
Pennsylvania	158	154*	153	147*	....	....	....	....	....	....	17,987,217
Texas	812	903	633	633	925	1040	800	800	1096	1215	490,101,261
West Virginia	79	72	71	66	54	41	34	36	91	104	3,586,653
Wyoming	12	9	8	8	9	11	7	5	9	7	25,863,538
Total	2391	2406	1874	1855	2266	2316	1428	1525	2049	2259	1,344,576,159

*Includes water-intake and pressure wells.

This oil-well cement
STAYS FLUID AND PUMPABLE

IMPROVED UNAFLO IS MORE THAN SLOW SETTING... IT'S RETARDED!

YOU CAN USE A HEAVIER SLURRY WITH IMPROVED UNAFLO

Improved Unaflo, the cement with the retarded set, provides slurry that remains both fluid and pumpable for extended periods under different hole temperatures and pressures.

Several oil-well cements, including *improved* Unaflo, often are referred to as "slow setting." But Unaflo is more, different, and better than that. Unaflo has a delayed—a postponed—a *retarded* set. The difference is important.

DIFFERENCE BETWEEN SLOW AND RETARDED SET. Normal portland cement begins to stiffen when water is added, continues to stiffen thereafter, and does so at a much faster rate when temperature increases. Slow-setting cement stiffens similarly but at a slower rate. But Unaflo has a *retarded* set, and does not congeal but remains fluid and pumpable for the entire period of retardation, after which it hardens normally. It does not stiffen, or jell, but remains fluid under different hole temperatures and pressures during the period required for pumping, including unforeseen delays and shutdowns for extended periods.

ADVANTAGES OF RETARDED SET. This characteristic is what oil men said they wanted and what Unaflo provides. Because of its *retarded* set, Unaflo cement—

1. **Permits placement of slurry while still fluid;**
2. **Remains fluid and pumpable after period of rest;**
3. **Minimizes the hazard of sticking the pipe;**
4. **Provides a safer cement for various cementing operations, including deep, tough jobs.**

IMPROVED UNAFLO DEVELOPED BY RESEARCH. Despite the satisfaction Unaflo *retarded* cement gave upon its introduction, Universal Atlas was not satisfied. Its research engineers continued their studies in the laboratory, in the plant, and in the field. The results of this research are your gain. *Improved* Unaflo is even more uniform in composition, more uniform in reaction to different types of mixing waters found on different jobs, and more uniform in retardation of setting time under different hole temperatures and pressures. As a result, *improved* Unaflo provides true cementing economy. Use it for safer, better cementing, especially on *deep, tough* jobs. Ask your dealer for Unaflo. Universal Atlas Cement Company (United States Steel Corp. Subsidiary), Amicable Bldg., Waco; Oklahoma City; Kansas City; Chicago; Birmingham.

PE-U-24

A safeguard for wells
UNAFLO OIL-WELL CEMENT

MAJOR *Pipe Line* ACTIVITIES

PROGRESS on the new 101-mile, 8-in. crude oil line from the Apache pool of Caddo County, southwest Oklahoma, to the greater Seminole field in Seminole County has been reported by The Texas Pipe Line Company.

With pipe delivery for the line beginning late in November, it is reported that The Black Construction Company is laying the line as rapidly as possible. The line is scheduled to be completed and tested by February 1, according to a report by J. K. McGoldrick, president of The Texas Pipe Line Company of Oklahoma.

Construction of a new pipe line from the Chapel Hill field in eastern Smith County to the East Texas field proper is planned by officials of Sinclair Prairie Pipe Line Company. The line from the East Texas field will tie into the Gulf Coast trunk line from its producers in the Chapel Hill area. It will be a 4-in. main line with a 6-in. gathering system.

Immediate construction of a 772-mile pipe line costing $30,000,000 is planned by the Hope Natural Gas Company, a subsidiary of the Standard Oil Company of New Jersey. More than 160,172 tons of 20-in. pipe will be used in the line, which is expected to be laid from Kanawha, County, West Virginia, to the large natural gas reserves of Louisiana and Texas. The company has applied to the Office of Production Management for a preference rating on the project and for allocation of necessary materials. Officials of the company have reported that the line could be completed and put into service within a year if materials are made available.

The line will transport 100,000,000 cu. ft. of natural gas daily at the beginning of operation. According to present plans, the pipe line will cross 9 large rivers, including the Mississippi, and cross the states of Mississippi, Tennessee, and Kentucky.

Three gas companies, The Hope Natural Gas Company, The East Ohio Gas Company, and The Peoples Natural Gas Company, supply natural gas to an area of concentrated industry in Ohio, Pennsylvania, and West Virginia.

The companies reported that in 1939, they had supplied 31,300,000,000 cu. ft. of gas to the industries of the Pittsburgh-Cleveland-Youngstown area. Defense demands in 1941 are expected to increase these figures to 48,200,000,000 cu. ft. The total annual demand for the duration of the emergency would approximate 80,000,000,000 cu. ft.

Twenty-seven miles of 12-in. pipe line between Big Lake and San Angelo, Texas, has been removed by the Lone Star Gas Company to lay a new line from its Brad gasoline plant in northwestern Palo Pinto County to the Sewell pool in Young County. The new line is expected to have a capacity of approximately 25,000,000 cu. ft. per day. Residue gas from the Brad plant will enter the company's system serving the Fort Worth-Dallas, Texas, area. The old line from Big Lake to San Angelo formerly transported treated sulphur gas. A new source of sweet gas from Page field in Schleicher County will be used to supply the San Angelo area.

The company is also building 15 miles of 6-in. pipe line with a maximum capacity of 3,000,000 cu. ft. per day. This line will extend from the Pottsville field to the town of Hamilton, Hamilton County, and will tie into the company's main line system at Hamilton. There are 8 gas wells, producing from 1,000,000 to 75,000,000 cu. ft. per day, in the Pottsville field, which was purchased from the Seaboard Oil Company by the Lone Star Gas Company.

Indications that the company plans to enter the Tri-Cities field in Henderson County as a buyer of the area's gas output was seen when work began on purchase of right-of-way from there to the Cayuga field.

Approximately 17 miles of 4-in. pipe line for natural gas transportation is being constructed by the Natural Gas Pipeline Company of America in Illinois. The line will supply gas to De Kalb and Sycamore. Contract for the job was let to Midwestern Engineering and Construction Company, which has its headquarters in De Kalb.

A second natural gas pipe line under construction for Natural Gas Pipeline Company of America is a 90-mile loop of 26-in. pipe near Muscatine, Iowa.

The natural gas pipe line of the Cities Service Gas Company from Cement to Oklahoma City, Oklahoma, is completed except for about a 10-mile section on the Oklahoma City end of the line. This line is being constructed of 16-in. pipe and is 53 miles in length. Contract for the line's construction is held by Midwestern Engineering and Construction Company at present maintaining headquarters in Oklahoma City. F. E. Stanley, president of the construction company, is supervising the work.

More than 200 miles of 10-in. pipe-line loops have been completed by contractors for the Gulf Refining Company, Pipe Line Division, Tulsa, Oklahoma. Williams Brothers Corporation contracted and laid 3 loops of 43 miles in Oklahoma; B. and M. Construction Company built 4 loops of 72 miles in Missouri, and Jones and Brooks constructed 5 loops of 88 miles in Illinois and Indiana. The last loop to be completed is in Missouri near the Mississippi River. Completion of the loops will enable the Gulf company to increase deliveries from 43,000 to 53,000 bbl. per day. Delivery of pumping equipment for the station near the Ohio-Indiana boundary will provide an increase of deliveries from Dublin, Indiana, to Buckeye Junction in Ohio, near Lima, from 27,000 bbl. to 30,000 bbl. per day.

The Texas Pipe Line Company is constructing a 6-in. line from Johnsonville to Rural Hill, Illinois, a distance of 34 miles. The lines will provide an additional outlet for the Hoodville area. Williams Brothers Corporation has contracted for the line. The construction company will also construct a 72-mile, 6-in. natural gas line for The Texas Pipe Line Company from Salem, Illinois, to Lawrenceville, Illinois, to serve The Texas Company's refinery there.

Shell Oil Company, Inc., is erecting buildings and installing pumping equipment and tanks at a cost of more than $1,000,000 at the company's 8 pipe-line terminals on the new Plantation Pipe Line extending from Baton Rouge, Lousiana, to Greensboro, North Carolina. Pump capacity has been increased to raise delivery of the line from the original plan of 1,260,000 gal. per day to 2,520,000 gal. per day due to the present emergency.

The new pipe-line terminals, located in Meridian, Mississippi; Birmingham, Alabama; Atlanta, Georgia; Spartanburg, South Carolina; Charlotte, North Carolina; Greensboro, North Carolina; Chattanooga, Tennessee, and Knoxville, Tennessee, are expected to be completed about the middle of 1942.

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THE Petroleum Engineer

JANUARY, 1942

Reducing the Quantity of Salt Water Produced With Oil

Petroleum Engineer Exclusive

☆ Use of subsurface chokes in tubing string below pump or gas-lift equipment is one method that has proved effective in East Texas field

by F. J. Mikeska

Division Engineer, Gulf Oil Corporation

SINCE the discovery of the East Texas field in 1930, it has been of great interest to the industry as a whole, and to the nation in general, to witness the manner in which this, the largest field in the world, has been produced.

As plans are being currently discussed and put into execution for more effective means of disposing of the salt water produced in the East Texas field, it is of interest to note the methods that are now employed by an increasing number of operators in the field to *reduce* the quantity of salt water produced.

Of the various methods employed in an effort to reduce the volume of salt water lifted with the oil production, the one that has proved effective in many respects has been the use of a subsurface choke in the tubing string below the pump or gas-lift equipment. It is this method that will be discussed here.

As implied, the use of a subsurface choke has usually been restricted to pumping or gas-lift wells, the number of which is increasing in the field as more wells cease flowing from year to year.

F. J. MIKESKA

received an A.B. degree in mechanical engineering from Oklahoma University in 1928—Spent one year at Barranquilla, Colombia, with one of the subsidiaries of the Electric Bond and Share Company—In August, 1929, went to work for the Gulf Oil Corporation at that company's electrical power plant in the Hull field, Texas—Was later transferred to the Thompson field, Texas, as production engineer where he spent five months—Since that time has been in the East Texas field—Is now division engineer and makes his headquarters at Kilgore.

The accompanying sketch, Fig. 1, indicates the general arrangement of the choke with respect to the pump or gas-lift device. A packer attached to the lower end of the tubing is employed to close the casing, thereby causing the fluid produced to pass through the choke. By thus restricting the flow to the quantity that will pass through the choke, a more uniform rate of inflow from the formation is obtained and the tendency for abnormal water encroachment due to coning is definitely retarded.

The function of the choke and the principles underlying its use are best explained possibly by reviewing its development. By deduction, the idea of employing a subsurface choke came as a result of the successful use of a surface choke on flowing wells as a means of controlling water encroachment. The need for a choking medium on pumping wells was further emphasized by the characteristic tendency of pumping wells in East Texas to "head up" and flow when the fluid column in

the tubing is lowered, thereby reducing the back pressure imposed on the formation. As a result of the excessive pressure drop in the formation during the unrestricted natural flowing periods thus induced, water encroachment by coning is believed to be accelerated.

Reasoning along these lines led to the first installation of a choke nipple in the tubing string below the pump. A packer was employed as in the present method but no outlet to the annulus between the tubing and casing above the packer was provided. Results from this method were not satisfactory because of the difficulty in adjusting the capacity of the pump to equal the rate of flow of fluid through the choke.

In view of this, it was logical to consider provision for using the annulus above the packer as a reservoir for "storing" the inflow of fluid from the producing formation at a relatively slow rate during a 24-hr. period. Thus the well's allowable production (20 to 50 bbl. gross fluid per day) can be pumped in 2 to 4 hours at an efficient rate insofar as the pump is concerned and still maintain a safe rate of production through the choke without interfering with the controlled rate of production through the choke.

Analysis of Water Control

In presenting the results attained in East Texas by the use of subsurface chokes below the pump or gas-lift equipment, it is not intended to infer that the principles involved are by any means new.

The generally accepted conception of water encroachment by coning pictures a more or less well-defined plane or surface of contact existing initially between the oil body and the underlying water. When a well is drilled and completed in the oil-saturated section, presumably a reasonable distance above the water-bearing stratum, and the well begins producing, the reservoir system changes immediately from a condition of static equilibrium. As flow is established and fluid enters the well bore, lines of flow are established throughout that portion of the reservoir "controlled" by the well. When only one well serves as an outlet for the reservoir fluid, all lines of flow are directed to this one means of outlet. When two wells are producing from the reservoir, the division of flow control between the wells is determined basically by the relative volumes produced from the two wells. As the number of wells producing from a common reservoir increases, the number of flow patterns likewise increases.

Pictured ideally, the oil-water contact plane in a reservoir such as the East Texas field surrounding a newly completed well is shown in Fig. 2. Regardless of the rate at which fluid is produced through the well, there will be some tendency for water to encroach. When the rate of withdrawal becomes excessive, however, the coning effect becomes more pronounced.

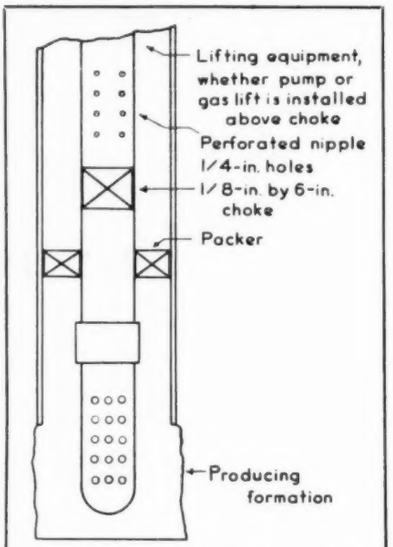

Lifting equipment, whether pump or gas lift is installed above choke
Perforated nipple 1/4-in. holes
1/8-in. by 6-in. choke
Packer
Producing formation

Fig. 1. Sketch indicating general arrangement of the choke with respect to pump or gas-lift device

Viewed simply, the effect of withdrawal rates on the coning tendency involves the pressure imposed on the face of the sand in the well bore. It is essential when visualizing flow conditions within an oil-bearing formation to keep clearly in mind the size of the openings through which the fluid must travel.

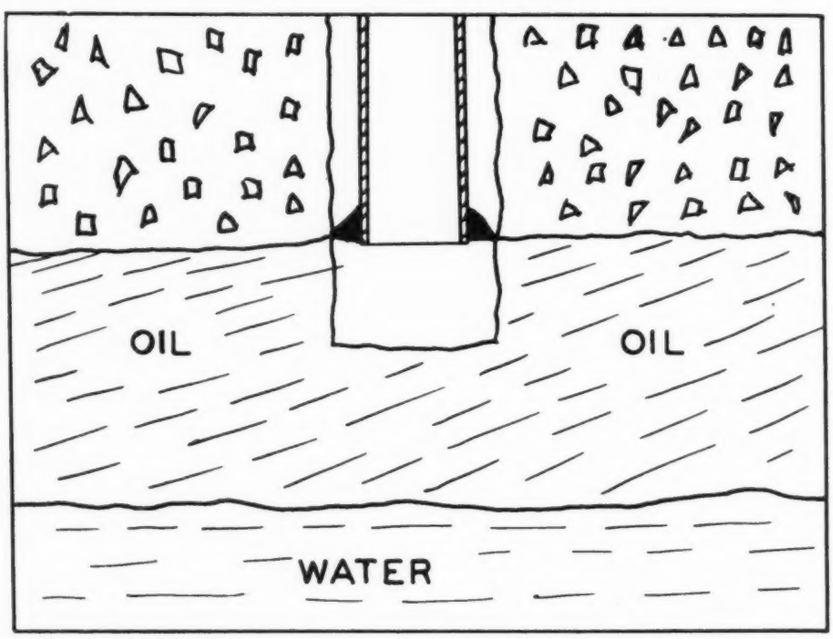
Briefly, if the rate of withdrawal is restricted, there is less differential or pressure drop and it is "easier" for the oil to enter the well bore from greater distances laterally with less possibilities of water entering from the lower part of the formation. On the other hand, when withdrawal rates are excessive, the increased flow differential encourages the encroachment of water, causing an increase in the percentage of water produced and resulting in a situation such as is sketched in Fig. 3.

These principles are generally recognized by production engineers. It is more or less accepted practice to employ methods of imposing back pressure on flowing wells in order to restrict the rate of flow and thereby forestall water encroachment due to coning.

When wells have ceased flowing, however, and it becomes necessary to employ artificial methods of lifting the fluid, too often engineers have been resigned in their acceptance as unavoidable the harmful effects accompanying the unrestricted flow characterized as "heading".

By employing methods whereby the harmful effects of heading are mitigated, the coning tendency should be inhibited. Such a method is the use of subsurface chokes of the type described here.

Fig. 2. Ideal oil-water contact plane in a reservoir, such as the East Texas field, surrounding a newly completed well



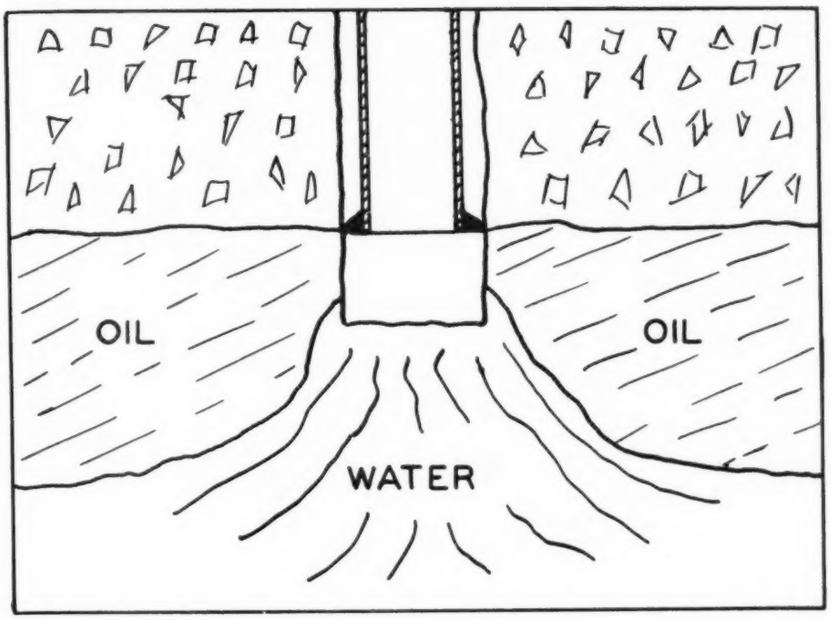


Fig. 3. Indicating water encroachment when withdrawal rates are excessive, resulting in increased percentage of water produced

Performance Data

The first experimental installations of subsurface chokes of this type in East Texas were made as long as four years ago. It is, of course, generally known that removable chokes of the type that are locked in place by slips and run and removed by wire lines were installed in some of the first flowing wells completed in East Texas as a means of controlling the water-oil ratio. Installations on a broader scale of the type discussed here were not made, however, until approximately two years ago. Accurate figures are not available but it is estimated conservatively that approximately 200 pumping wells in the East Texas field are now equipped with subsurface chokes. The specific installations may vary depending upon the company involved but the principle is essentially similar to the method described here.

Performance data on all the installations in East Texas are likewise unavailable. Experience with 134 pumping wells and 15 gas-lift wells in which subsurface chokes have been installed indicates that the increase in the rate of water production is definitely retarded. Reports from other operators, both independents and major companies, who have installed subsurface chokes indicate that their experience with similar installations has been generally satisfactory.

It has not been considered practicable to maintain detailed performance records on all 149 wells in which subsurface chokes are installed inasmuch as the benefits derived from the use of chokes has been more or less self-evident. A direct comparison has been difficult, moreover, because all wells in which pumping or gas lift has been required during the last two years have been equipped with subsurface chokes. Consequently, there has been no direct opportunity on a broad scale to study performance of wells *not* equipped with chokes.

A rather interesting though incomplete comparison was obtained, however, on one 12-well lease on which four of the wells were converted to pumping at the time when installation

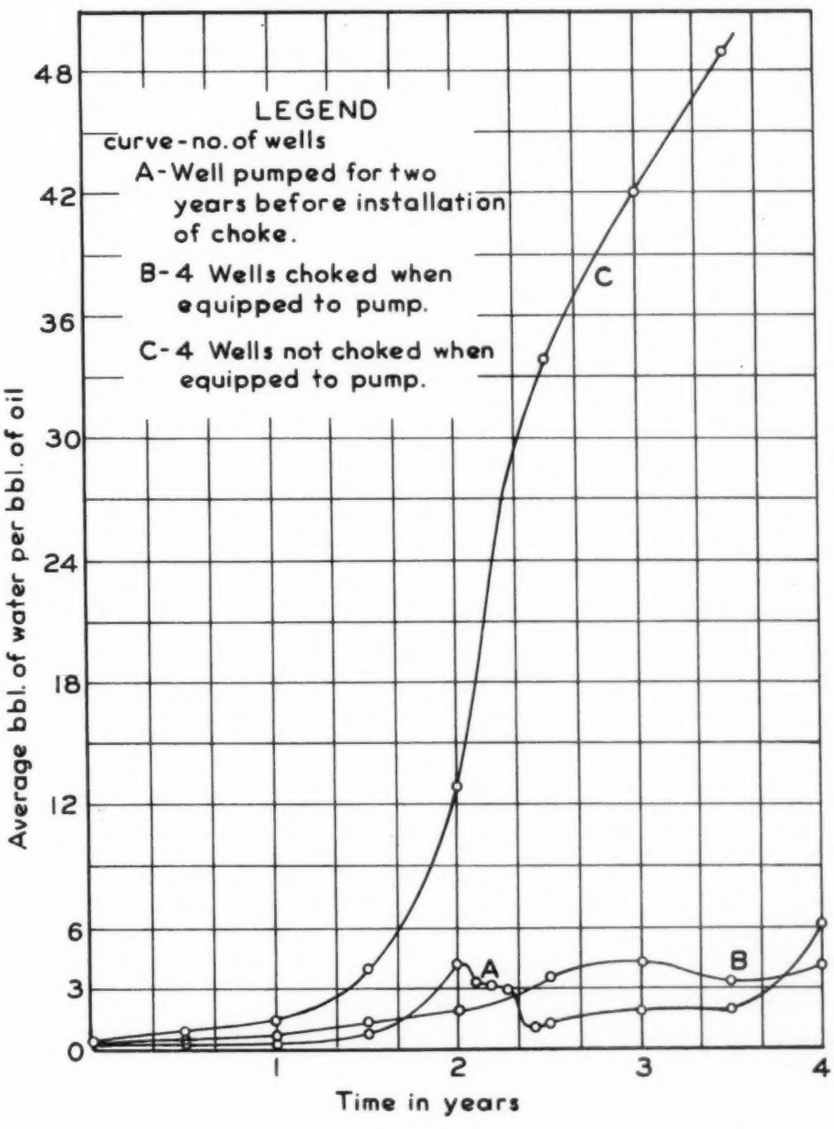


Fig. 4. Oil-water production record of wells on pump in East Texas field

of subsurface chokes in pumping wells was entirely on an experimental basis. By the time the value of choking was more definitely established, the water production from these four wells had increased so materially that it was inadvisable, in fact impossible, to consider restricting the flow by the use of chokes. The fact that two of these four wells have been plugged and abandoned and the other two produce 97 percent water whereas the other wells on the lease in which chokes were installed are still producing their allowable with reasonable volumes of water, is rather encouraging evidence supporting the value of chokes as a means of retarding the rate of water encroachment.

It is important to emphasize that the use of subsurface chokes does not always reduce the current rate of water production in the manner indicated in Fig. 4 by Curve "A." This curve represents the production record on only one well that was pumped for two years prior to installation of a choke. It is reasonable to expect, however, that choking of pumping wells will arrest the *rate* of increase in water production. This tendency is indicated in Fig. 4 by a comparison of Curves "B" and "C". Curve "B" is the record of a group of pumping wells that were choked. Curve "C" is a record of a group of pumping wells that were not choked. All these wells are on the same 50-acre lease. The value of choking pumping wells is emphasized by these curves, which indicate that when pumping wells not equipped with chokes have reached a water production of 40 to 50 bbl. per bbl. of oil produced, the water production from choke-equipped wells has increased to only 5 bbl. per bbl. of oil produced.

It is again emphasized that the results portrayed in Fig. 4 are based on a relatively small number of wells. Nevertheless, the comparison is of more than passing interest when one visualizes the possibilities of subsurface choking if applied to all wells in the East Texas field at the time they begin producing water and require artificial lifting.

If it is reasonable to assume that subsurface choking might be as effective in all pumping and gas-lift wells as in those now equipped with chokes, the curtailed volume of water production in the East Texas field could easily prove of great importance.

Removable Choke

In nearly all wells equipped with chokes thus far, the choke nipple has been made-up in the tubing string just above the packer, thus being fixed in place and not removable except by pulling the tubing, which of course involves unseating and pulling the packer.

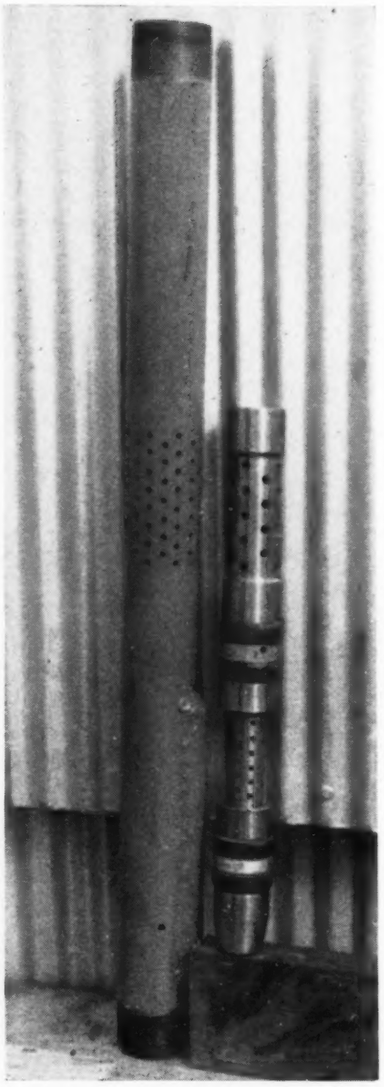


Fig. 5. Removable choke of the type discussed

Recently, a choke has been designed and patented that eliminates the need of pulling the tubing in order to inspect or replace the choke. The choke assembly consists essentially of a perforated nipple made-up in the tubing string; and the choke proper. The choke is attached to the lower end of an insert type pump, or to the standing valve if a tubing pump is used, so that it may be run-in and removed with the pump or standing valve. The perforated nipple, blanked off in the lower end, serves as a landing or seating nipple for the pump and choke. Although only three or four commercial installations of this choke assembly have been made thus far, the installations are being studied closely. The removable feature of the choke should aid in reducing well costs materially.

Conclusion

Based on the results obtained thus far by employing subsurface chokes to control water production, the method appears to have considerable merit. Although there may be conditions in individual wells that might preclude the successful use of a choke, it is believed that application of the method at least should be given consideration by every operator confronted with the problem of producing wells in East Texas by artificial lifting methods.

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Explosives Act Effective

The declaration of a state of war makes effective the Federal Explosives Act of October 6, 1917, which prohibits the manufacture, distribution, storage, use or possession of explosives, or the ingredients of explosives, unless a license has been obtained from the Director of the U. S. Bureau of Mines, it is announced by Dr. R. R. Sayers, Director of the Bureau. Exempted are explosives used by the Army and Navy.

A revised version of the 1917 Act has been passed by both Houses of the present Congress, and the measure is now in conference to iron out a minor difference between the House of Representatives and the Senate, Director Sayers states. In its essentials, however, it is similar to the original law.

The 1917 Act and the present bill are both designed to keep explosives or their ingredients, from getting into the hands of persons hostile or disloyal to the United States or who are judged not to be reliable or experienced in the use of explosives, and provide heavy penalties for violation of any of its provisions or of any rules or regulations promulgated thereunder by the Director of the Bureau of Mines with the approval of the Secretary of the Interior.

All manufacturers, vendors, purchasers, analysts, educators, inventors, investigators, foremen, and other users, except workmen who obtain their explosives from licensed foremen must obtain a license under the terms of the law. As soon as application forms are available, the Director said, a public announcement to that effect will be made, and rules and regulations will be promulgated.

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So, You Want to be a Petroleum Engineer?

☆ Considerations in deciding upon petroleum engineering as a profession

PART 1

by Lester C. Uren

Professor of Petroleum Engineering, University of California

"SO, you want to be a petroleum engineer? Fine! Come in, have a chair. Let's talk it over. Smoke? No? Good! May save you from blowing up the works some day. How old did you say? Eighteen? Just about right. Some of the potential 'Phi Betas' make it too early. They're well advanced academically, but otherwise immature. Rarely do they profit by a college course to the extent that they would after a little more contact with industry. Even a year or two can make a lot of difference at your age. It would be a fine thing if every one could work for a year, or at least for a summer vacation, in the industry of his choice, or just helping some one engaged in the profession he chooses to follow.

Maybe You're Wrong

"By the way, how did you come to decide that you'd like to be a petroleum engineer? Father well placed in the industry? Reared in an 'oil town'? Well, those are usually good reasons and yet I've known them to give some potentially good lawyers and doctors a wrong start. You know, our dads have the best intentions in the world, but they are sometimes blind to characteristics inherent in each individual that give promise of success in one direction rather than others. You know, our parents usually have aspirations for future professional success and social position of their children that they have been working toward for many years. A father, well established in his own profession, realizing the difficulties that must be encountered in entering upon a career, and wishing to be in a position to assist his son in achieving economic independence, often seeks to lead the young man into his own profession. Often pride of position, or even a desire to perpetuate a name in an industry or conserve family assets in a well-established business enterprise, will perhaps unconsciously have a determining influence in the desire of a father to have his son 'follow in his foot-steps'.

"Youngsters of high-school age are often led into ill-considered decisions. Probably no decision that one is called upon to make during his lifetime is more important than his choice of a profession, yet the average individual must make this choice at a time when he is immature, when he has had too little time or opportunity to test his own capabilities or determine for himself on any scientific basis, in which of various professions he may ultimately be happiest and most interested. Happiness and interest in one's profession are vital things. We must give a lot of time and thought to the selection of a lifetime profession. Sometimes it goes 'stale' on us after we've spent a lot of time and money getting ready for it; an all too common experience that mars many a young man's career. And the tragedy of it is that it could have been avoided in many cases by timely analysis of the individual's potential capacity and characteristics.

"Now, you say you've been reared in a community in which the petroleum industry is dominant; that your father is active in this industry. Are you sure that these circumstances have not unduly influenced your decision to be a petroleum engineer? Most boys of high-school age have but a vague notion of how men in different professions earn a living. The kind of work their fathers do is best known to them and understood. The whole outlook of the family in which the individual has been reared is more or less dictated by the occupation of the father, and so it is but natural that many a young man in making his choice of a profession, chooses that of the parent, with which he is most familiar. Then too, if one is reared in a community in which all or nearly all the workers earn their living in a certain industry, naturally the young man approaching maturity, thinks of his own future in terms of the occupations upon which he has seen men engaged in his own community. Yet, this kind of work, this industry to which his interest has been confined by the accident of birth and environment, may actually be one for which he is physically and temperamentally unfitted.

"On the other hand, I've known many young men to enter upon a course of preparation with the objective of becoming petroleum engineers, who have seen nothing of the petroleum industry and who never knew any one engaged in it. Something they had read concerning the industry and its romance attracted their interest; or, someone had said it would be a profitable kind of work in which to engage. Often these are city-bred boys who have little or no concept of the kind of life the oil-field worker is called upon to live. A good plan in such cases, is for the prospective engineer to spend a summer vacation or a semester or two working for an oil company in some routine capacity where he may have opportunity to observe the kind of work that is required of different individuals and the kind of environment in which the oil company employee lives and works. If he emerges from this experience with a desire for more, we must respect his choice unless there is reason to believe that he is otherwise unqualified.

L. C. UREN

received his Bachelor of Science degree from the College of Mining, University of California, in 1911 and has taught courses in mining and petroleum engineering there since 1912, ranking as senior professor in the petroleum division of the department of mining since the inception of the division in 1915—Is a member of the research committee and director of Project No. 28 of the American Petroleum Institute, and a member of the research committees of the American Association of Petroleum Geologists, of the American Institute of Mining and Metallurgical Engineers, and of the National Research Council—He is a member of the professional societies mentioned, and of Sigma Xi, Tau Beta Pi, and Theta Tau honorary fraternities—Has been on sabbatical leave from the University of California and during the last several months has visited leading oilfields of the country, returning to his teaching post the first of the year.

"The young man who chooses petroleum engineering as a career merely because he thinks it might be more profitable than others, or because someone has told him it is easy to find employment in the petroleum industry, deserves little of our attention. He usually changes his mind before he has gone very far, in favor of something else that then seems more attractive in these respects. One should not be too much concerned with immediate prospects in any industry or occupation, for these may quickly change. The mere existence of a shortage of technical help in a few years may create over-supply. Often, employment conditions change with the business cycle and a prosperous industry today may be quite the reverse four years hence. It is helpful in this regard, to appreciate that there is always room for a good, well-trained and properly equipped man in any industry or profession; but he must be good—at least better than the average —if he would be assured of his opportunity.

"There is a group of young men entering the petroleum engineering profession in considerable numbers, many of whom deserve sympathy and special consideration. These are men who have made false starts in other directions, later to find as a result of contact with the petroleum industry, that they are interested in it to such a degree that they are willing to abandon their earlier objective and begin over again their professional training. Often such a decision comes after preparation for the original objective is completed or nearly so, and a real sacrifice in time and money invested must be made. It is comforting in such circumstances to realize that no educational effort in any direction is ever entirely loss and the individual who 'swaps horses in the middle of the stream' may yet profit by the experience and knowledge gained in getting that far. An individual who is determined to make the necessary readjustments, usually finds sufficient satisfaction and pleasure in his ultimate achievement to compensate for the additional time and expense involved.

"We should admire the man who is willing to admit his earlier mistakes and make such sacrifices as are necessary to correct them. It is only human to cling to and seek to justify decisions once made. Some young men are stubborn enough to adhere to a choice of profession made during early 'teens,' long before there is any adequate basis for such a choice. He may go through life, at heart disliking his trade or profession and secretly envying others the pleasure they find in their work. Such individuals lack the courage to admit to themselves and those around them that they were human enough to make mistakes. Nothing is more important than satisfaction in one's way of earning a living. Work that we enjoy doing is a game: a pleasurable experience to which we can return day after day with renewed interest. Work that we do not enjoy becomes mere drudgery. One should be ever ready to make any change in his plans for a professional career whenever he becomes convinced that such a change promises a more congenial occupation in which he is more likely to succeed.

"Relatives and friends are often responsible for these premature decisions. Even before the youth enters high school, they begin to plant suggestions and ideas in his plastic mind; and in high school, the young man is often made to feel that he lacks purpose and decision unless he has developed some definite career objective. Yet, how could he be in a position to make an intelligent choice of a career in view of his limited experience, at such an age? Many students are sensible enough to resist this pressure, and on entering college, do so with the frank admission that they have as yet made no choice of a profession: that this is what they hope the college will help them decide. This is indeed, the truly scientific position for a young man to take. It is perhaps an indication of a type of mind that will be successful in an engineering profession. He may deliberately plan to sample different fields of academic work for a year or two with the purpose of finding subjects in which he is most interested and which may prove to be an index of his aptitude for one or another of the professions. Most universities offer orientation courses and otherwise organize work in different departments to make it possible for the student to follow this plan. For example, a student may reasonably feel quite certain on entering college that he wishes to take up some kind of engineering, but has not yet decided which of the several engineering professions he will ultimately select. Most engineering schools have a common first-year requirement and the program of the second year may differ but slightly in the different curricula. Thus, it is often possible for the engineering student to defer his selection of a specific field of specialization until the end of his first or even second year of college work without loss of time. Many educators believe that the student should not be encouraged in declaring a choice of a specific objective until he has had opportunity to 'find himself' in the educational process; and the student who has not 'made up his mind' would do well to take full advantage of the opportunities that most of the schools now offer to aid in professional orientation.

"A situation sometimes presented is one in which the student cannot decide between two or perhaps more objectives, in each of which he believes himself to be equally interested. The obvious solution for this difficulty is to sample both. A few months of practical work in each possible field of endeavor will usually resolve the uncertainty in favor of one or the other occupation. If actual employment cannot be obtained in the prospective industry or profession, it is usually possible to arrange observation trips to industrial centers where the kind of work in which one is interested may be seen in progress. Actual work in an oil field, though highly desirable for the prospective petroleum engineer, is not essential in order to see and understand much of what goes on there. A suitable introduction and brief explanation to the field superintendent will often bring one the privilege of closely observing operations under way in the field and may lead to friendly discus-

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Each year many hundreds of young men enter American colleges and universities with the purpose of preparing for a career in petroleum engineering. At such a time, they and their parents have many questions concerning the problems incidental to choice of a career, matriculation, curriculum and scholastic requirements, and adjustment to the conditions of academic life. Students nearing graduation from college also have many questions relative to the problem of bridging the gap between college and industry.

For twenty-five years, L. C. Uren, Professor of Petroleum Engineering at the University of California, has been helping students find the answers to these and other questions incidental to their preparation for a petroleum engineering career. Lately, during a period of sabbatical leave from his university duties, he has been visiting the various colleges and universities of the United States that offer instruction in the field of petroleum engineering, with the purpose of comparing their requirements and instructional facilities.

This is the first of a series of articles to be published under the title "So, You Want to be a Petroleum Engineer?" that will be of interest to all present and prospective petroleum engineering students, their parents, and future employers.

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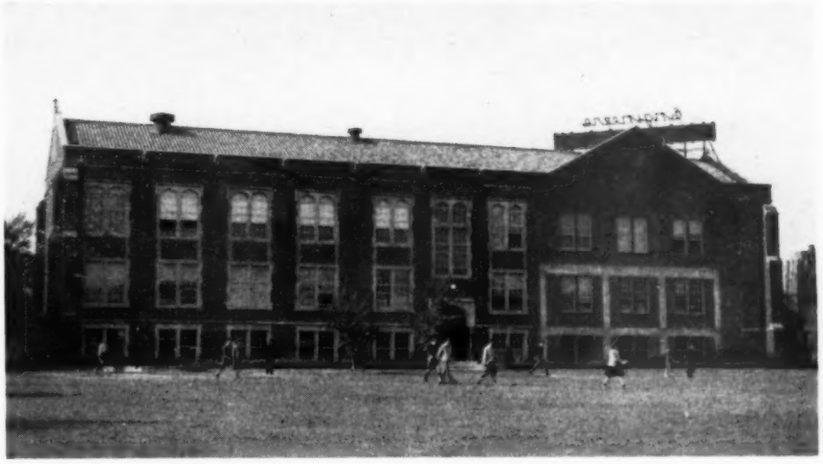
sion and advice. Men engaged in professions are usually willing to discuss their work with prospective recruits and give helpful advice.

"Some educators profess to believe that by appropriate aptitude tests they can in a few hours determine whether or not an individual is likely to succeed in a particular profession. One would be presumptious, however, to deny any student the right to enter upon a course of preparation for the career of his choice merely because he failed to 'measure up' to the accepted standard in any so-called aptitude test. They perhaps apply broadly, but there are too many exceptions to the rule to make such tests an infallible guide. Some students are superficially brilliant; they appear well in aptitude tests but lack the tough mental fiber and practical outlook that is characteristic of successful engineers. Others, who appear to be below par in such tests may not yet have had the experience or the right kind of teaching to awaken their interest in the things that make for success in engineering work. Even the man who has made the effort and failed in his first year or two of an engineering course, may yet come back and redeem himself after some stimulating experience that awakens in him new incentives and a greater desire to succeed.

"A more dependable index of a student's aptitude for an engineering profession is found in the record of his high-school work. Successful completion, with good grades, of courses in high-school mathematics, physics, and chemistry, and ability to apply them in practical problems, is regarded by many as an indication of one's aptitude for an engineering career. There would appear to be good reason for this point of view for these are subjects that are directly prerequisite to the basic courses in every engineering curriculum. To these academic subjects, some would add facility with and a liking for work with hand and machine tools and a lively interest in the practical aspects of industrial operations of all kinds.

"Although interest in a chosen profession and a determination to succeed in it are of greatest importance in qualifying one for success in any career, it must be admitted that they are not the only attributes that have a bearing in determining ultimate achievement in it. Some men are constitutionally unfitted for petroleum engineering work. Perhaps they lack the mental capacity to master the underlying technology. Others, though able to meet academic standards, seem unable to apply what they learn in a practical way. Some brilliant students lack the robust health and physical stature to withstand the hard physical work that many employers consider a necessary preliminary to petroleum engineering work. A good physical appearance and pleasing personality go a long way in gaining the interest of an oil company personnel officer. There is, for example, the case of the oil company that employed only blonde service station attendants who were at least six feet tall. Although this is, no doubt, an exaggerated case, it is nevertheless true that petroleum engineers in the employ of many oil companies are more or less 'typed.' Competent engineering graduates of foreign birth—particularly Orientals—have little chance of obtaining employment with American oil companies. Such considerations should not be over-emphasized, however, for there are notable exceptions, and a man of truly superior capacity as an engineer will be of interest to many employers in spite of adverse personal factors.



Engineering Building, University of Oklahoma

Maybe You're Right

"Well, we seem to have found many reasons why one should not hastily reach a decision to enter upon a petroleum engineering career. Let's look now at the other side of the picture. What can be said by way of encouragement, to qualified young men who have made a carefully considered decision to prepare themselves for this field of endeavor? What can young engineering graduates entering the petroleum producing industry during the next few years expect? What are their employment possibilities? Will they enter a highly competitive field? What remuneration may they expect to receive? What opportunities will exist for professional advancement?

"The petroleum industry is America's second most important industry, our greatest mineral industry. It gives employment to more than a million people. Each year, more than half a billion dollars is spent on oil-field operations and every dollar of this great sum is, or should be, expended under engineering supervision. Petroleum production engineering as a science is, as yet, relatively undeveloped. Proper engineering supervision of all oil-field operations could provide economic justification for employment of many more engineers than are today engaged in it. The industry is becoming ever more technical. More science is involved in modern methods of oil-field exploration than in any other mineral industry, and the future will demand more and more technical training of the men who engage in it. Not only men classed as engineers, superintendents, and foremen have need of this training, but men in subordinate administrative positions—even those engaged in routine drilling, producing, and maintenance operations—must be technically minded. In time, we may expect to find a much larger percentage of trained engineers in the field organizations of oil-producing companies than is the rule today. As managers, superintendents, and staff officials of the 'old school' retire, we may expect to see them succeeded by young, technically and practically trained engineers who have been found to possess administrative ability. The highest oil company positions are thus coming to be recognized as properly open to engineers. The employment opportunities and chances for professional advancement in this field of endeavor may thus be said to be excellent.

"As for remuneration, the young petroleum engineering graduate may expect a somewhat better salary in return for his services than the average technically trained man of like attainments in most other engineering fields. Yet, as the supply of men especially trained for this industry increases, we may expect to see this differential diminished. When we consider that the engineer is

usually employed in the industry virtually in the category of an apprentice for several years while he receives his practical training, the $150 per month or more starting salary that, in the petroleum industry, is frequently paid young men just out of college, is attractive. Furthermore, advancement from this beginning salary is rapid for capable men who adapt themselves quickly to the character of work to be performed.

Is There a Future for Petroleum?

"Some young men considering petroleum engineering as a profession are troubled by the knowledge that petroleum is a wasting resource and that known reserves are limited. They fear that some years hence, after they are fairly established in the industry, dwindling reserves and diminished activity in oil production may reduce technical employment. To those who understand the industry and its ways, this fear seems groundless. It is quite certain that we shall continue to have a very substantial petroleum industry in this country for a time spanning at least the lives of all now living. Furthermore, if we are to visualize a slowly waning petroleum industry, the declining years are certain to place more and more emphasis on technology: to require the services of more rather than fewer engineers. As a natural resource becomes higher in price—as would be the case in the event of declining production—we can afford to spend more in stimulating its recovery; and this means deeper drilling, more efficient and higher-cost production methods that require greater technical skill in their application. We may therefore conclude that for the young man who is inclined toward engineering as a profession and is constitutionally equipped for this type of work, the petroleum producing industry promises increasing rather than diminished opportunity.

"If one likes variation in his occupation, with frequent change of scene and character of work performed, petroleum engineering usually affords this. Part of the work is in the office or laboratory, part in the field. Operations are often widely scattered, so that the engineer moves about through the field in the conduct of his work. One problem engages his interest today, another tomorrow. The larger oil companies frequently have operations in many districts, so that staff men are often called upon to do a great deal of traveling. A large percentage of the time may be spent in healthful, stimulating, out-of-doors activity, with enough physical effort to satisfy the robust type of young man who so often finds the confinement and monotony of office routine irksome. For the man who enjoys laboratory research and development activity, there are many such opportunities in the more specialized aspects of the oil-producing industry. Some American oil companies have interests abroad, so that it is possible for their technical men to be assigned to foreign operations, with incidental opportunities for foreign travel and living for a time in other countries.

What Does a Petroleum Engineer Do?

"Frequently the young man who has seen nothing of oil-field operations and has had no contact with the oil industry and its ways, asks: 'Just what kind of work is the petroleum engineer called upon to do?' The best brief answer to this question is that he must be able intelligently and skillfully to participate in and eventually supervise all oil-field operations. The problems presented are varied in character and frequently are so complex as to require a high degree of technical skill and wide scientific knowledge in their solution. Common problems include those incidental to oil-field development, such as construction of roads, power, water supply and communication facilities and construction of camp buildings; planning and analyzing development programs, including decisions relative to spacing, arrangement and time and order of drilling wells; the operations incidental to drilling, including transportation and erection of drilling rigs and closely related operations of installing casing and excluding water from wells; methods of well completion, installation of production equipment, and estimating productive capacity.

"The production phase of the industry includes studies of subsurface reservoir conditions that govern the production of oil and gas; the installation, testing, and operation of well-pumping equipment, operation and control of flowing and gas-lift wells, well maintenance and repair work and conditioning of wells to obtain maximum production efficiency. Related to the production phase is the care and handling of oil and gas after they are brought to the surface: gas-trapping, dehydration of oil, pipe-line gathering and transmission of gas and oil; gauging, sampling, and testing of oil and gas. Special so-called 'secondary' methods of oil recovery designed to improve production efficiency and obtain an additional 'crop' of oil after ordinary methods based on utilization of natural expulsive forces have failed, require close engineering supervision.

"A special province of the petroleum engineer is that of maintaining well and property records, such as well logs and other subsurface data obtained during the drilling process. Property and well surveys and maps, records of production, cost data, materials and equipment records and tests are commonly entrusted to engineering personnel. Special phases of this work involve the making of well surveys, electrical logs, depth-pressure surveys, depth-sampling of fluids, inspection and testing of formation samples and oil, gas, and water obtained from different strata. Still more advanced aspects of the work of the petroleum engineer include property management, appraisal of producing properties, and work involved in proration and other methods of production control.

"The three foregoing paragraphs present but a broad outline of the more common oil-field operations and problems in which the petroleum engineer is expected to participate. There are in addition, other more highly specialized phases of petroleum engineering work with which we need not here be concerned. A careful scanning of a good technical journal serving a given field will often disclose the character of problems that are currently engaging the interest of men employed in it. For example, any young man who is considering entering the petroleum engineering profession would find a representative cross-section of the problems with which he might expect to be in future concerned, in a file of recent issues of *The Petroleum Engineer*, or the Transactions of the Petroleum Division of the American Institute of Mining & Metallurgical Engineers, or the Bulletins of the Production Division of the American Petroleum Institute.

Think It Over

"Well, what do you think of all this? Still think you'd like to be a petroleum engineer? Better 'think it over' some more before you decide. Get advice from others: every one has a different 'slant' on these matters. Don't, however, let any one else 'make up your mind' for you; and weigh carefully the advice you get. Not all who offer advice to young men in your position are qualified to give it, and you'll get many warped ideas. Give careful consideration to the suggestions of those close to you: they have your own best interests at heart and are best able to judge your personal qualifications. But when all the conflicting viewpoints have been analyzed, let the final decision be your own. You, yourself, must be thoroughly convinced of the wisdom of your choice. Then, if you are still interested, come back another day and we'll talk about the problems incidental to admission to college and the kind of preparation you will receive in your college course."

EDITOR'S NOTE: This article will be continued in an early issue.

☆☆☆

Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Treating Processes

Class Meeting No. 10

(Continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils, it usually denotes an interchange of discussion among the class members themselves.

THE main features of the copper sweetening process are given as:

1. Savings in chemical costs
   (The only chemical used being oxygen)
2. No loss in octane number during sweetening
   (Octane number has stood up on all tests, where with doctor treats they lose from one half to one number)
3. No loss in gasoline during treatment
4. Retention of natural gum inhibitors in gasoline
5. Improvement of quality of product
6. Decreased operating costs
7. Low investment

"In sweetening a gasoline with a copper reagent, the mercaptans are converted completely to disulphides, whereas in doctor treating, and especially in those of the lead sulphide or continuous type, there are formed alkyl polysulphides, which are extremely objectionable. These polysulphides result in a gasoline becoming corrosive to copper strip after exposure to light for a very brief period. Also, tertiary mercaptans lead to the formation of objectionable compounds during hypochloride treating. None of these difficulties are encountered in copper sweetening, the reaction proceeding smoothly and completely to the disulphide form."

So far as operating costs or treating costs are concerned, I was unable to find any good data, but they say in the paper from the Phillips Petroleum Company that in treating a natural gasoline that was found to be very difficult to treat using the hypochlorite process, that after installing the copper sweetening process, the savings in chemicals paid for the installation in 35 days, and they have given cost figures of labor and chemicals combined of 2 cents per 1000 gal. of gasoline on one plant, and on the other plant they had a total cost of $0.048 per 1000 gallons. Those are the only cost figures that I could find.

Pupil: Sachanen says that inasmuch as the copper salts are very powerful catalysts, even one part in a million of mercaptans must be removed. You said the use of inhibitors is recommended. From an economical basis, just what effect has that on the doctor treatment —the fact that you do not have to add deactivators?

Pupil: That might be a disadvantage, but in this Phillips pamphlet, it didn't say they used an inhibitor—they say the sodium sulphide removes all traces of copper.

Pupil: Sachanen says that is impossible.

Pupil: Well, that is their idea as given in this paper.

Leader: This solid process is best adapted to recovery plant gasoline or

One of the flow sheets designed by class members for processing 38-deg. A.P.I. stock

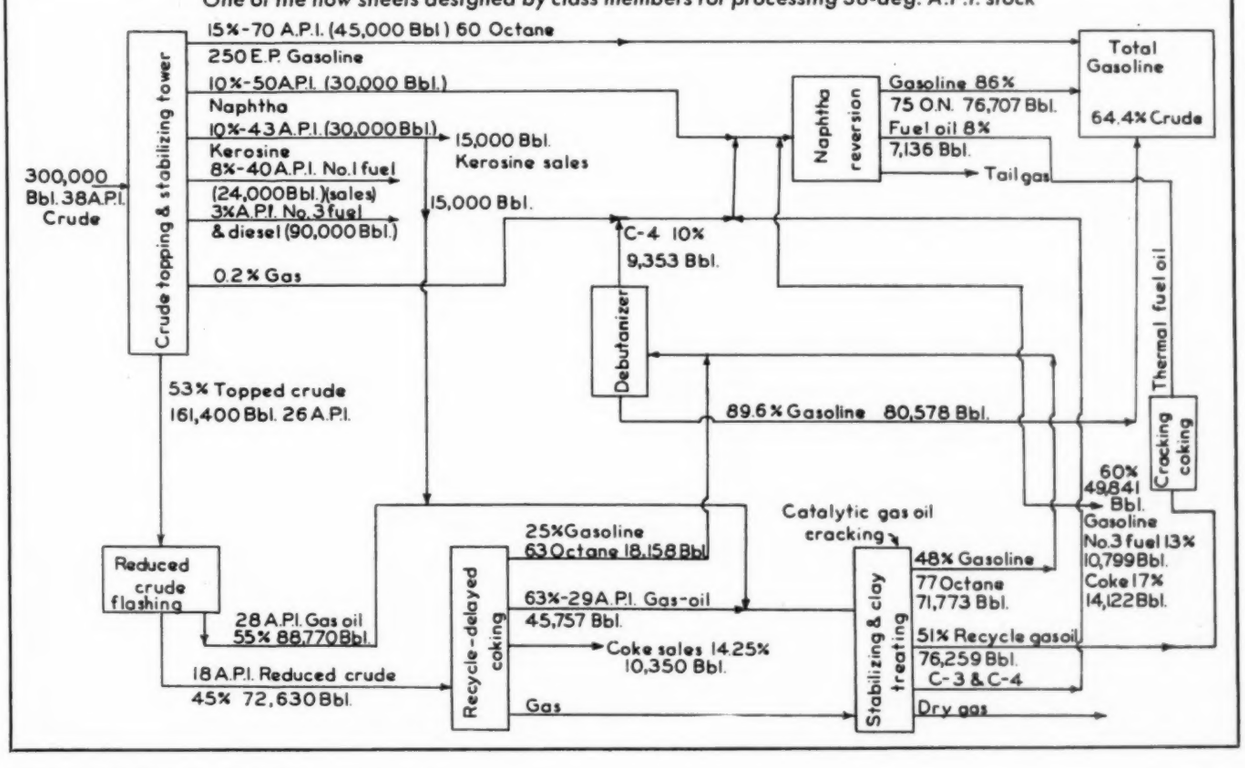


TABLE 10

Properties of untreated and solutizer-sweetened gasoline

	Untreated	*Treated*
Gravity A.P.I.	68.7	68.7
A.S.T.M. Distillation		
I.B.P., °F.	103	103
10 percent, °F.	126	126
50 percent, °F.	170	170
90 percent, °F.	269	269
Endpoint, °F.	371	371
Color, Saybolt	30	30
Mercaptan sulphur, percent by weight	0.09	0.0004
Total sulphur, percent by weight	0.12	0.03
Octane number (A.S.T.M. motor method)	69.5	70.0
Tetraethyl lead requirements:		
cc. per gallon to 75	0.65	0.38
cc. per gallon to 80	2.20	1.30

References:
Yabroff, *Ind. and Eng. Chem.* 32, 257-262, (1940).
Yabroff and Border, *Refiner*, 18 (5) 171-6, 203, (1939).
Border, *Oil and Gas Journal*, 39, (26) 55-56, (1940).

TABLE 11

	Treated	*Treated and Distilled*
Octane number	Unaffected	
A.P.I. gravity	53.2	55.9
Gum (copper dish) mg.	290.0	3.0
Sulphur, percent	0.28	0.19
Mercaptans	0.17	0.007
Color, Saybolt		30

natural gasoline and has had the best history.

Pupil: Didn't you say the natural inhibitors were retained in the gasoline?

Pupil: The natural gum inhibitors are retained in the gasoline. "The so-called natural gum inhibitors in gasolines are hydroxyl derivatives which are more or less completely removed by strong caustic solutions. Thus, it is commonly noted that the oxygen bomb induction period of many gasolines is materially shortened during the treatment with the strongly alkaline doctor solution. It is possible in many instances to avoid entirely the use of caustic solutions in the copper sweetening process, thereby retaining such natural gum inhibitors as are present in the gasoline."

Pupil: You would have to eliminate the caustic wash to retain all inhibitors.

Leader: Yes.

Pupil: I thought the caustic wash was just to remove hydrogen sulphide.

Leader: That is the primary purpose. I want you to be sure to keep this in mind: In the copper sweetening process disulphides, but no polysulphides, are formed. Phillips has worked hard to avoid formation of polysulphides, which are detrimental to inhibitor and lead susceptibility.

Pupil: Are either of those plants easily adaptable to a quick change in the stock—are they more or less continuous treating? Could you treat Kansas straight-run and Oklahoma straight-run and turn around and treat a different stock in the same plant?

Leader: I think we could use the same plant.

Pupil: Sachanen says that other sulphur compounds as well as gum and gum-forming constituents are not affected by copper sweetening.

Leader: I believe that is correct—just a conversion of mercaptans to disulphides.

Pupil: It said there was some loss in metallic copper.

Leader: Yes, there is a slight loss.

Now let's discuss the Shell Solutizer process.

Pupil: On May 17, 1940, Shell Oil Company, Inc., placed in operation at its Wood River, Ill., refinery a 15,000-bbl. per day solutizer sweetening plant, which is the first treater of this kind to be erected. Reports on the laboratory investigation and pilot plant operation of the solutizer treatment have been published in some of the trade journals in the last two years.

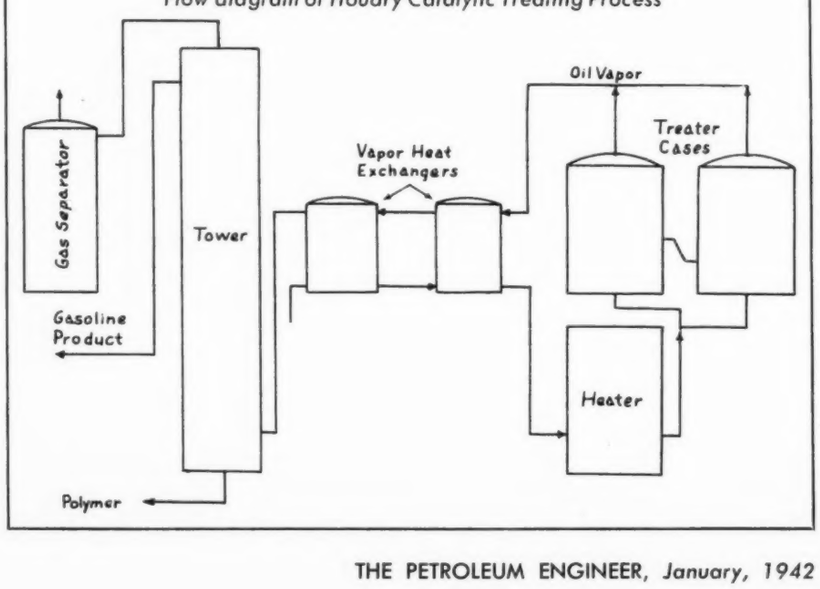
Treatment of sour gasoline with aqueous alkaline solutions, in general, does not remove the mercaptans completely enough to produce doctor sweet products; because the heavier mercaptans are very difficult to extract. In extracting mercaptans with aqueous solutions such as potassium hydroxide and sodium hydroxide, the following equilibrium is established:

$$\underset{\text{(oil phase)}}{RSH} \rightleftharpoons \underset{\text{(aqueous phase)}}{RSH} \rightleftharpoons \underset{\text{(reacted)}}{RSH}$$

The quantity of mercaptans that reacts with the basic ions at equilibrium is dependent upon the quantity dissolved in the aqueous phase and this is determined by the quantity in the oil phase. By the addition of a suitable "solutizing agent" (6 normal potassium hydroxide and 3 normal potassium isobutyrate) to an aqueous alkaline solution the quantity of mercaptans that will dissolve in the aqueous phase is increased and will shift the equilibrium to the right, thereby increasing the concentration of the mercaptans in the aqueous phase. This property is more pronounced for the heavier mercaptans than the lighter ones thus permitting sweetening of the full boiling range gasolines from which straight caustic solution extracts only a small percentage of mercaptans. By heating the solution both of the above equibilars are shifted to the left and by stripping with steam the mercaptans can be removed sufficiently to permit the solution to be used to produce doctor sweet products in the extraction system.

A brief description of the Wood River plant: it consists principally of an extraction and regeneration system.

Flow diagram of Houdry Catalytic Treating Process



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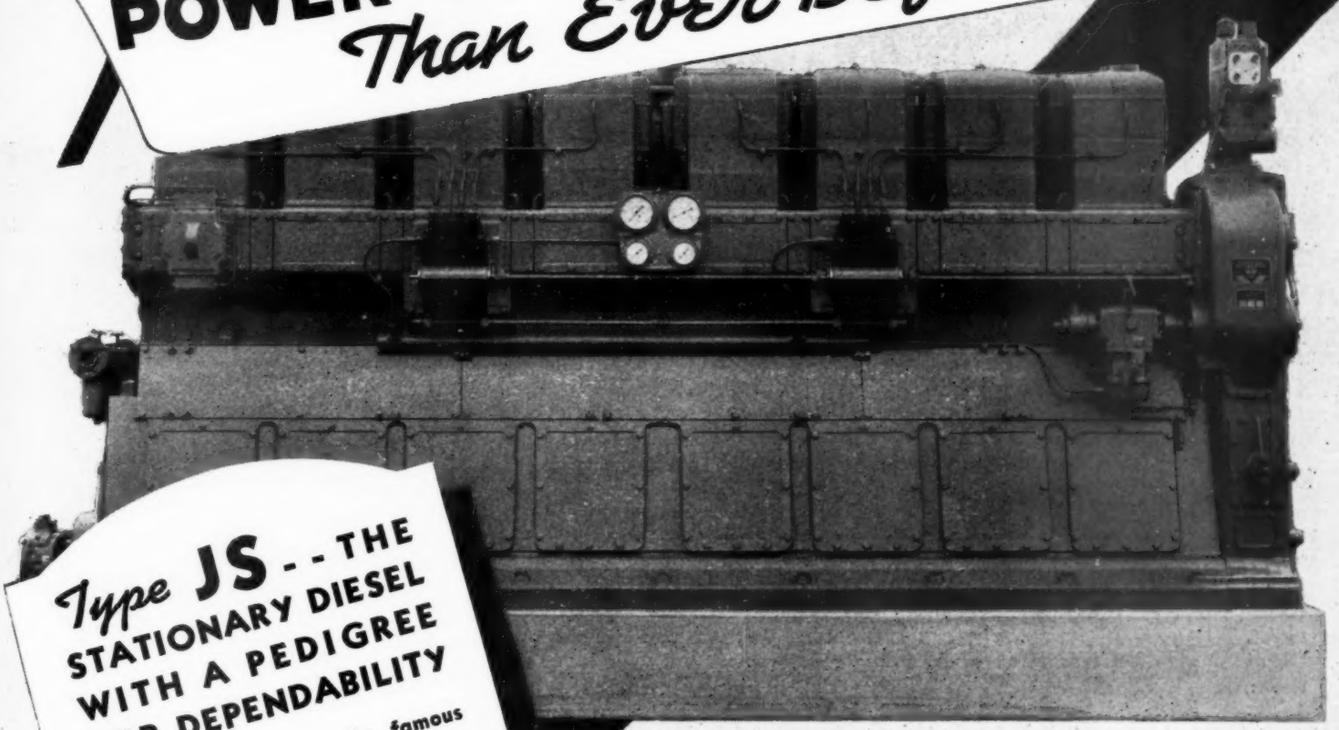

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TABLE 12

	Raw		Treated	
A.P.I. gravity	50.8*	52.0†	51.0*	52.3†
Endpoint, °F.	437	437	434	436
Color	Off	Off	27+	28+
Copper dish gum	510	480	11	11
Octane number	67.5	65.0	68.0	65.0

*Cracked gasoline from Mid-Continent crude.
†Cracked gasoline from Kansas crude.

The charge is taken from three stabilizers and passed through a weak caustic solution to remove hydrogen sulphide. The charge is cooled to 85°F. and passed through a coalescer, which is packed with steel wool, to remove traces of caustic solution. The cooled gasoline enters the extractors and flows up the tower countercurrent to the descending solutizer solution. The overhead product is passed to a settling tank, thence through a coalescer to remove traces of solutizer solution, and from there to storage. The spent solution is taken from the bottom of the extraction tower. A small percent of soluble gasoline is removed and the solution is heated to 285°F. through exchangers, thence it goes to the regenerator tower, where the mercaptans are removed from the solution by stripping with steam. The regenerated solution is passed back to the extraction tower.

Advantages of this process are said to be:

1. Ease of control, low utility requirements and negligible chemical consumption, i.e., the direct operating costs are low.
2. Complete removal of mercaptans.
3. Gasoline losses are insignificantly low.
4. Increase in octane number and lead susceptibility.

Pupil: You say it extracts all the natural inhibitors—any gum inhibitors?

Pupil: The use of alpha naphthol as soon as it comes off the tower is the inhibitor they use.

Pupil: And treatment doesn't hurt its inhibitor susceptibility?

Pupil: No.

Leader: In treating with caustic soda alone, what type of mercaptans would be removed?

Pupil: Just the lightweight ones—about 4 or 5 down the line and that is what would cause the equilibrium to shift as it does.

Leader: If you could remove half of it in the caustic wash on this process, then you would convert the rest?

Pupil: You don't remove as much as half of the mercaptans in the caustic wash, do you?

Leader: Well, you could.

Pupil: Is it an aqueous caustic wash?

Pupil: Yes.

Pupil: It would have to be about 30 gravity, wouldn't it?

Leader: Yes, somewhere in the 30's.

Pupil: Is there a low limit on the material that can be processed?

Leader: It is all treated within the gasoline range.

Pupil: This process seemed to be more flexible than any process yet, because you get no disulphides and you know what you are doing and there is not much chance of over-treatment or under-treatment and you can govern the isobutyl acid to the treating conditions. They treated some 400 endpoint stock and some butane and in every case the octane number was increased.

Pupil: How about the costs of treating?

Pupil: They didn't say much about that, except they did say the cost was less than doctor treating.

Pupil: You talked about mercaptan sulphurs. It appears as though they remove nearly all of them. What does it do to some of the other forms of sulphur present?

Pupil: That is in the alkaline solution.

Pupil: Thiophenes are properly removed by sulphuric acid.

Leader: They don't know yet what happens to all those sulphuric compounds.

Pupil: Then does pressure distillate require acid treatment?

Leader: No, I don't think it does.

Pupil: On a doctor treat, we have to give it an acid treat.

Leader: This process is used for finished gasoline right off the cracking units. You might say that the process is primarily to improve color, odor, and remove gum.

Now to conclude the discussion, suppose we cover the other treating processes briefly.

Lachman $ZnCl_2$ Process

The Lachman $ZnCl_2$ process consists of the treatment of cracked gasolines by an aqueous solution of $ZnCl_2$.

There are two reactions concerned in the process. The first, which is probably catalytic, is the selective polymerization of unstable hydrocarbons (diolefins). The olefins and aromatic hydrocarbons in the gasoline are unaffected.

The second reaction is the conversion of mercaptans to dialkyl sulphides according to the following equation:

$$2\,RSH + ZnCl_2 \rightarrow R_2S + ZnS + 2\,HCl.$$

A comparison of untreated and treated distillates is shown in Table 11.

One of the flow sheets designed by class members to refine topped crude

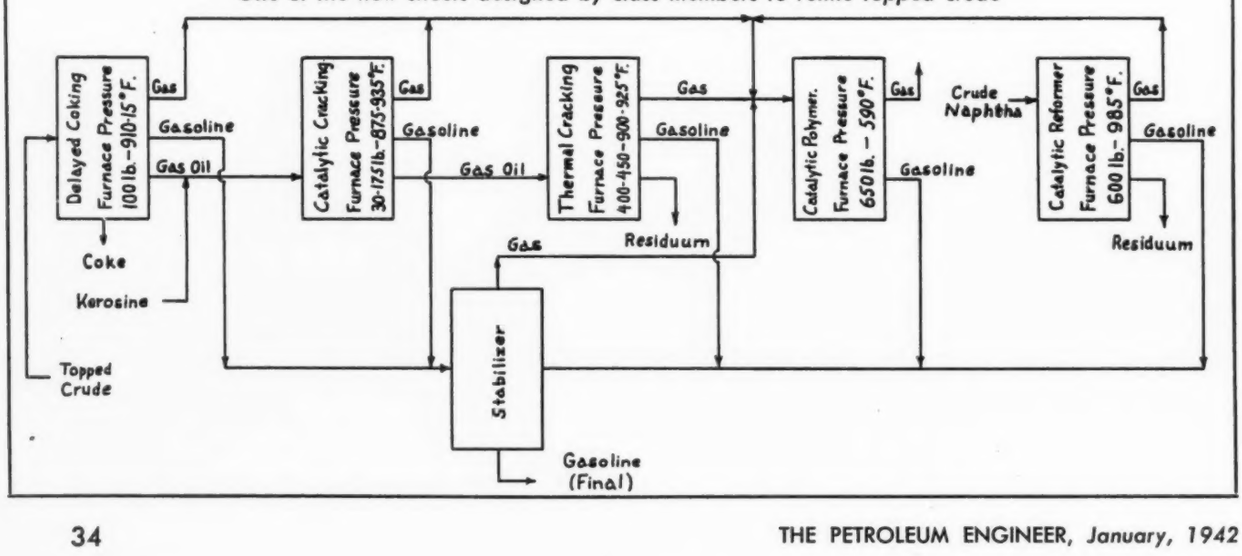

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TABLE 13

	Gasoline charge	*Gasoline products*
Octane number	77.1	77.2
A.P.I. gravity	52.6	53.2
Initial boiling point, °F.	94	91
10 percent, °F.	159	158
50 percent, °F.	298	294
90 percent, °F.	390	381
Endpoint, °F.	423	403
Recovery	95.0	95.0
Copper dish gum	35	6
A.S.T.M. gum	2	1
Oxygen bomb		10 hr.+
Doctor	Sour	Sweet
Copper strip	Corrosive	Non-corrosive

A brief description of the process is as follows:

The gasoline vapors are passed into a packed tower meeting the flow of $ZnCl_2$ solution. Due to the corrosive action of $ZnCl_2$ at the operating temperature, the tower packing must be of chemical tile.

The temperature in the contact tower is maintained at 302°-347°F. The contact time is usually two seconds. The $ZnCl_2$ solution varies from 70 to 80 percent by weight. The weight of $ZnCl_2$ per barrel of distillate is one to ten pounds.

HCl formed in the reaction is partly neutralized by passing through the line tower and then finished in a bubble tower with NH_3. The neutralizing towers are steel shells, brick-lined.

The treating losses in this process are small (0.23 percent). The consumption of $ZnCl_2$ is 0.1 to 0.03 lb. per bbl. of gasoline. The cost of the process is $0.0582 per barrel of gasoline plus the cost of sweetening.

Gray Tower Process

The Gray process is based on the selective polymerization of unstable unsaturated hydrocarbons (diolefins) found in cracked gasolines.

The diolefins are converted into heavier products of polymerization but olefins and aromatics are not attacked.

The disadvantage of this process is that sulphur compounds are not attacked.

A summary of the results of this process is as follows:

1. The composition of the gasoline does not change after treatment.
2. The color improves as a rule and always becomes more stable.
3. The amount absorbed by H_2SO_4 does not change after treatment. The iodine number decreases by two to ten percent.
4. The amount of sulphur in the gasoline does not change after treatment. The raw and tested gasolines may be compared by referring to Table 12.

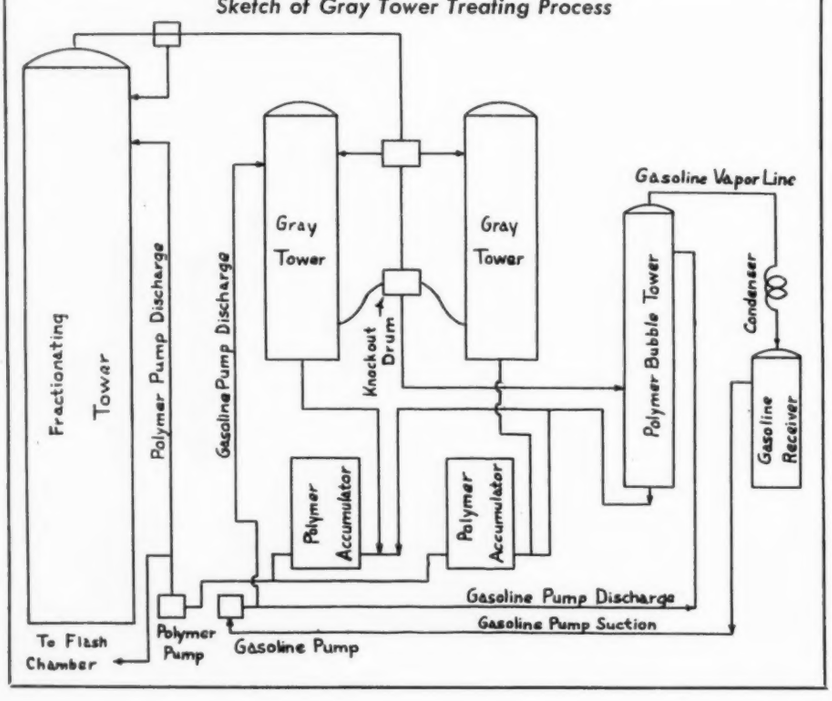
Vapors of cracked gasoline pass through a bed of Fuller's earth in Gray towers, which are connected directly with the fractionating column of the cracking unit.

Gasolines from paraffinic stocks, distillates, or produced under mild conditions of cracking are treated more easily by the Gray process than those produced from residual stocks or cracked under severe cracking conditions. One ton of earth at a pressure of 40 to 60 lb. per sq. in. treats a minimum of 2000 bbl. of gasoline or 0.5 percent of Fullers's earth calculated on the volume gasoline.

At pressures of 150 to 200 lb. per sq. in. about 4000 bbl. of gasoline may be treated. One run at 174-lb. pressure yields 3627 bbl. of gasoline per ton of earth. If the gasoline is to be inhibited after treatment, the throughput can be increased.

Operating costs of $0.023 per barrel plus royalty and sweetening costs are usual.

Sketch of Gray Tower Treating Process



Houdry Process

The Houdry catalytic treating process consists of vapor phase operations involving the passing of gasoline vapors through a catalyst at a temperature range of 392° to 752°F. and pressures from 15 to 100 lb. per sq. in.

The processing occurs in two stages: The first takes place in the desulphurizing zone of the catalyst cases. In this stage, mercaptans and H_2S are removed completely and at least 30 percent of the original total sulphur is removed.

The flow sheet is shown in an accompanying sketch and a brief description of the process is as follows:

The second stage is the polymerization of unstable hydrocarbons in the refining zone of the catalytic cases.

In the desulphurizing zone a relatively inert absorbent is impregnated with catalysts of nickel, cobalt, or copper oxides.

In the refining zone, catalysts consist of a blend of silica and aluminum with small proportions of nickel, cobalt, or copper.

The temperature in the desulphurizing zone is maintained at 572° to 752°F. and in the refining zone the temperature is below that of the desulphurizing zone and above 392°F.

The equipment used consists of:

1. A heater to vaporize gasoline.
2. Catalytic cases
3. Tower to separate the 1.5 percent polymers formed.

Yields of 97.7 percent gasoline and 1.5 percent polymers are obtained by this process.

The raw and finished products may be compared by referring to Table 13.

EDITOR'S NOTE: This series will be continued in an early issue.

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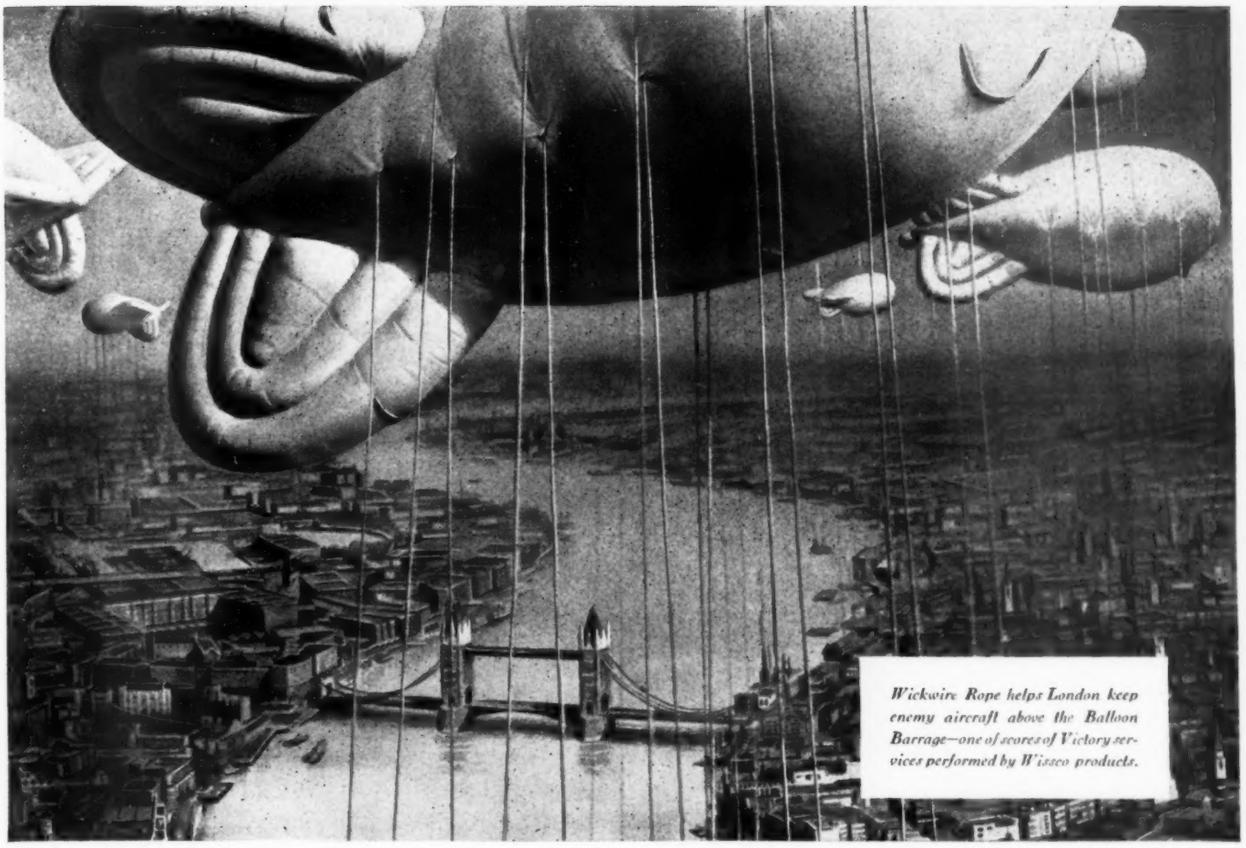

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WISSCO PRODUCTS

General view of the rig layout showing mud pumps, mud tanks, and engines

Drilling Rig Designed for Ready Portability

Valuable features include 90-ft. telescoping mast, semi-trailer tractor unit, complete mud unit, and drawworks arranged for flexibility

by Wallace A. Sawdon

Pacific Coast and Foreign Editor

COMPLETE portability combined with safe and efficient drilling facilities have been achieved with a drilling rig now being used by Continental Oil Company in the Turnbull oil field lying northeast of Whittier, California. The rig equipment consists of two main units mounted on semi-trailers and hauled by a semi-trailer tractor unit, all units being of road width and meeting legal requirements for load. All movement is made on pneumatic rubber-tired wheels. Of particular interest is the arrangement of the equipment when rigged-up for drilling operations.

Drilling and Pumping Units

The drilling and pumping units are mounted permanently on the semi-trailers, which have three axles in the rear. During transportation the front of the semi-trailer is supported on the tractor unit, which hauls one unit to a new location and then returns for the other unit. Incidentally, the tractor also hauls a light semi-trailer used for general lease work while the other units are drilling.

One main unit consists of the hoist, its engine, the folding derrick, and auxiliary equipment used with these items. The other consists of two mud pumps and their two engines complete with manifold, large double tool box, and lighting unit. As shown in the illustrations, the two units are mounted side by side with a walkway between. Before they are moved into place, guide tracks are laid at the location and the semi-trailers carrying the units are backed into position on these tracks. This provides for the alignment of the units in the desired position so that connections between the two units can be made rapidly and with minimum work. All water, mud, fuel, and electrical connections are built into the units. The forward ends of the trailers when rigged up, are the ends away from the derrick floor, and rest on tubular steel supports. Jacks placed near the wheels that are adjacent to the derrick floor relieve the load on the rubber tires.

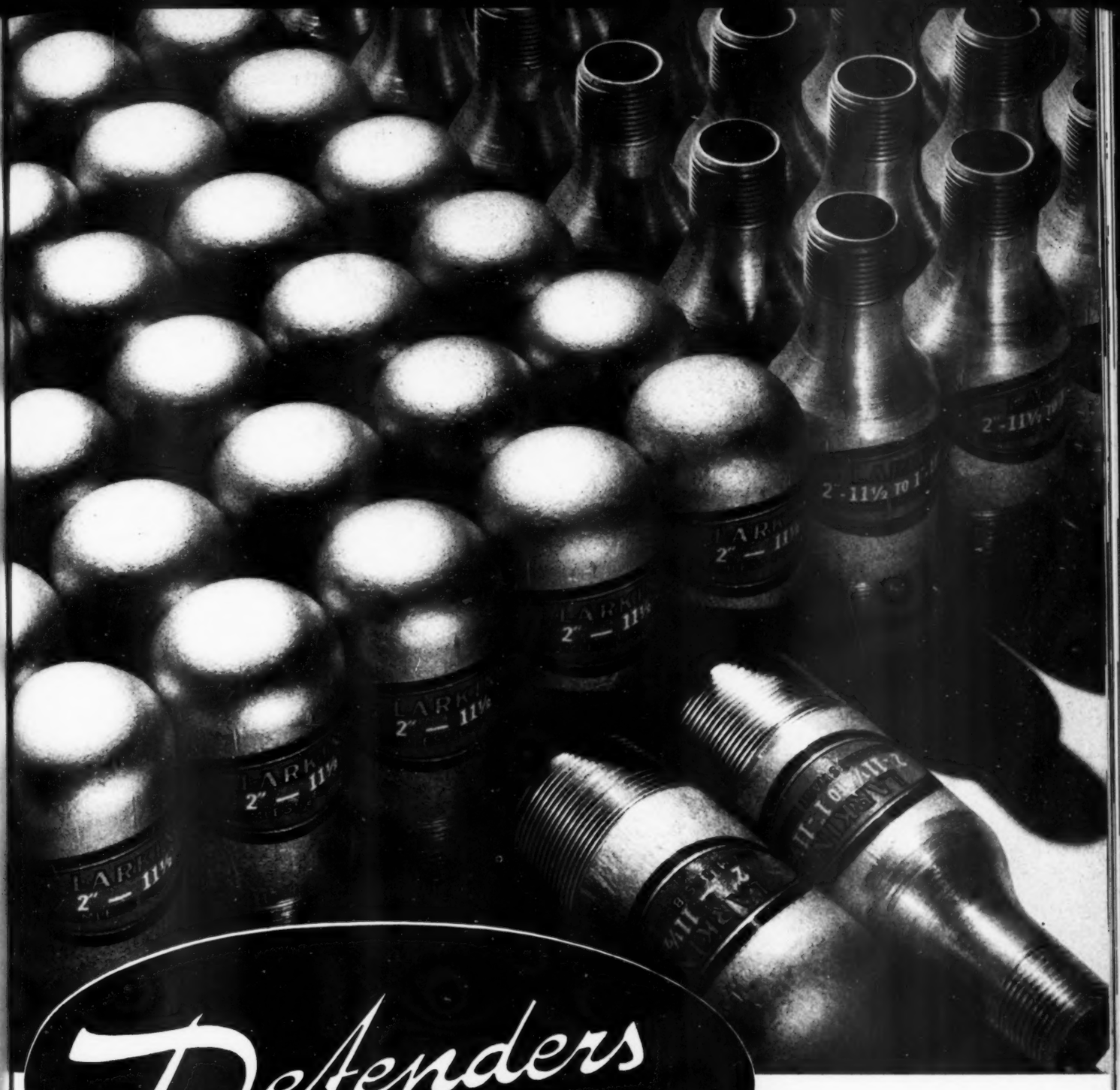
Derrick Floor

The derrick floor is supported by a unitized steel substructure and carries a recessed rotary table made possible by a special close-coupled landing head and collar control gate or blow-out assembly. The 16-ft. working platform and the walkways between the rig units and along the outer side of the hoist unit are made up of removable steel grating sections. The pipe rack is conveniently placed opposite the drawworks and consists generally of 8-in. by 8-in. stringers laid on the ground.

The mud is handled by small steel mud tanks and a steel settling "ditch" as illustrated. These are transported by ordinary trucks from one location to another.

Telescoping Mast

The mast or derrick is of the quick-lifting telescoping type and is 90 ft. in height when fully raised. It folds back over the hoist and hoisting engine when being transported and when the unit is in place at a location is raised to a vertical position by a hydraulic system



Defenders

EGIC POINTS

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Larkin Bull Plugs and Swage Nipples are forged from quality steels . . . seamless and weldless . . . uniform in length, shape and thickness . . . faced ends . . . reamed inside edges . . . accurate threads, chamfered for starting . . . Zincoted* by an exclusive process. Yes, Larkin Bull Plugs and Swage Nipples will hold all the pressure encountered . . . they're defenders of strategic points!

*In cooperation with the National Defense Program we are temporarily foregoing the well known Larkin Zincoting process on sizes above 7" OD which, for the time being, will be painted.

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LARKIN PACKER COMPANY, INC., St. Louis, Mo.

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powered by a water-cooled V-8 engine, which is part of the permanent equipment of the hoist unit. This engine then powers a winch that raises the telescopic section of the mast. This is a more or less familiar recent design of portable masts. The capacity of the mast is 240,000 lb.

The mast is arranged so that it can be separated from the semi-trailer and left erected at the well. This permits the use of the rest of the hoist unit at other locations equipped with the standard type derrick.

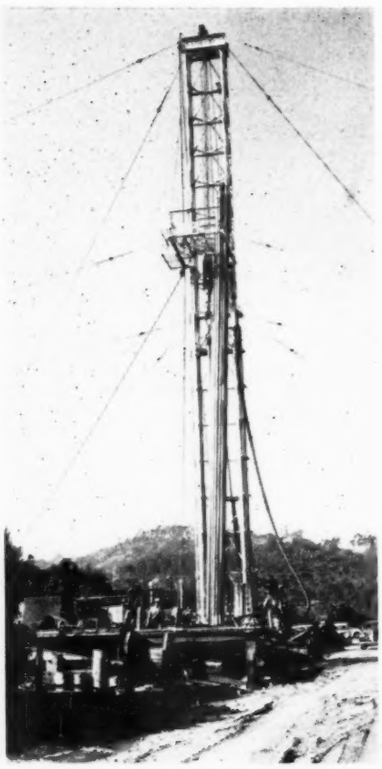
The hoist is a 3-shaft, double drum machine with 15-in. drum grooved for 1-in. line. Equipped with friction clutches it has four speeds forward and one reverse on the hoist drum, sand reel, and rotary drive. The engine driving the drawworks is 200 hp. and is provided with carburetors that make it adaptable to either butane or natural gas for fuel.

Weight of Units

The total gross weight of this unit and tractor is 64,414 lb. on the rubber, the weight being distributed as follows:

On front axle of tractor	5,338 lb.
On two rear axles of tractor	25,116 lb.
On three axles of semi-trailer	33,960 lb.

In this weight is included 4700 ft. of ½-in. sand line but not the guying material, rotary table and drive, catheads, rotary attachment, rotary countershaft, steel walkways, and platform or jacks. These are carried in a separate truck. The block and hook and 1500 ft. of 1-in. line are also transported separately when the limiting road weights established by law will not permit them to be carried with the unit. The catheads are always removed when on public roads inasmuch as they cause the unit to exceed the road width when left on the drawworks.



Portable rig drilling in Turnbull field, California

Pumps

The pump unit is also mounted on a semi-trailer supported at the rear by three axles, which is similar to the one carrying the hoist and mast. The unit is designed, however, specifically for the pumps and their motors. There are two 7¼-in. by 10-in. pumps, each powered by a 150-hp. engine equipped with carburetors for butane or natural gas fuel. As shown in the illustrations, the pumps are set parallel at the rear of the trailer, which is the end toward the working platform when the units are set up at the location. The pumps are driven through enclosed V-belts, one on one side of the unit and the other on the opposite side. The engines are in front of the pumps (when traveling) and are set across the trailer, one behind the other, with the tool box in front of them, just behind the lighting unit. The pumps can be operated singly, parallel, or in compound.

Anchoring Mast

Anchorage for the mast is of considerable importance with a portable rig of this type. Provision must be made for withstanding a stress of 18,400 lb. at each of the four anchors. The anchors used for this installation have been designed to exceed the required capacity by a generous margin and are constructed as illustrated in the accompanying sketch.

The ground is cut at an angle as shown and dug to the proper depth, the cutting angle being governed by the character of the soil. Undisturbed earth is left above the angular cut and a heavy anchor bolt is passed through a narrow trench cut through this virgin earth to the bottom of the excavation. This anchor bolt is attached to a length of junk pipe or angle iron, usually about 12 ft. long, which is laid in the bottom of the excavation behind a board of the same length. On the end of the anchor bolt aboveground is an eye to which is attached a specially designed yoke to carry all the guy lines anchored at that corner. The initial tension on the lines is taken with block and tackle and the final tension with a turnbuckle. The tension on the lines is established with a strain-indicating instrument and is thus uniform for each set of four lines serving as guys. The anchors are left in place after the well is drilled to provide for well-servicing work that may be necessary at a later date. The yoke is part of the guy-line equipment that goes with the rig. The anchor bolt left extending aboveground is painted white to show up readily.

The capacity of this portable rig for depth of hole, length and size of drill pipe, weight of casing strings, and for meeting definite drilling conditions can be determined by consideration of the capacity of the various units as given above.

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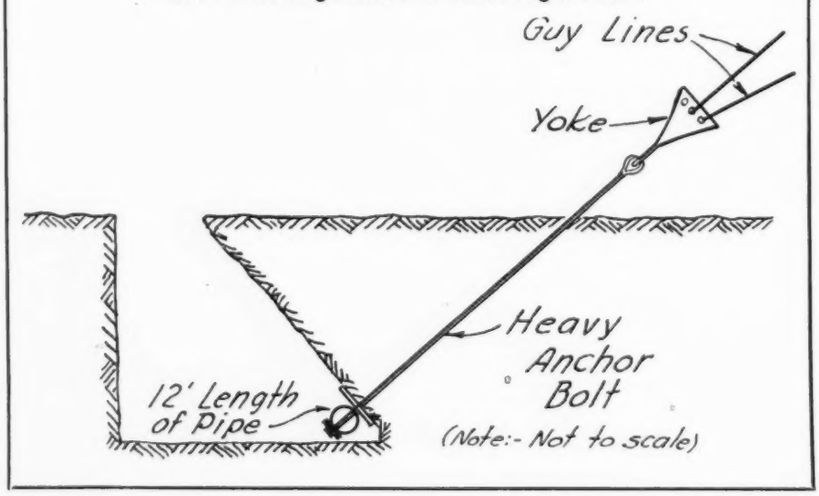
Sketch showing method of anchoring the mast



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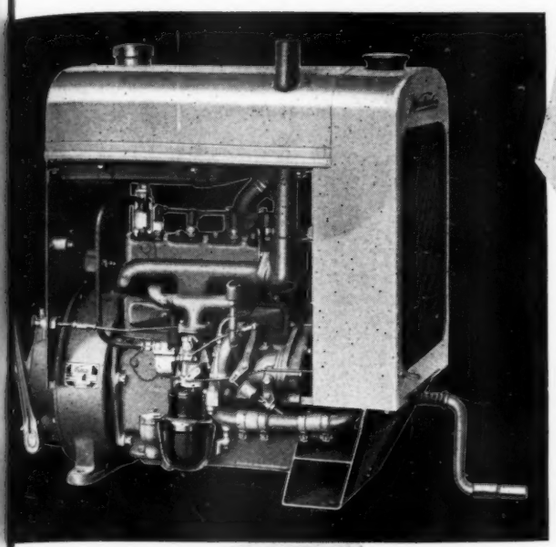
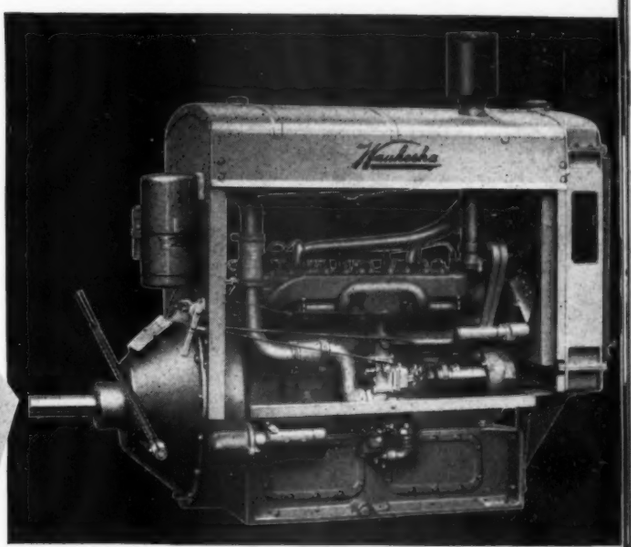
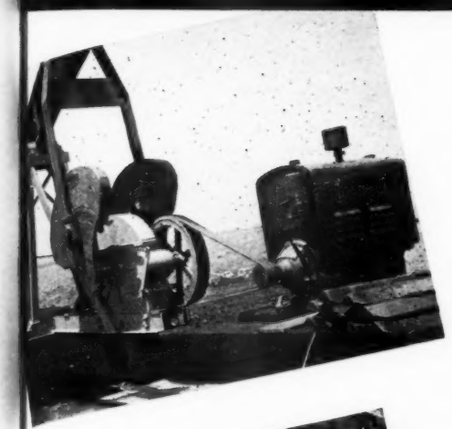
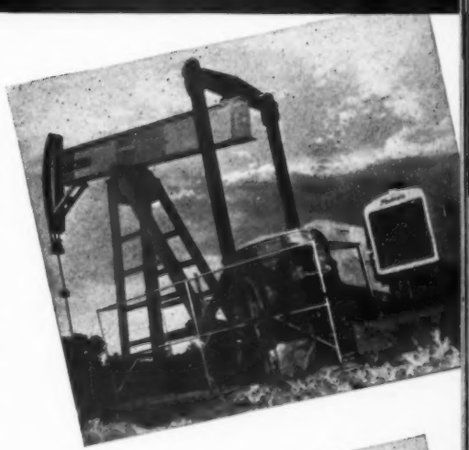


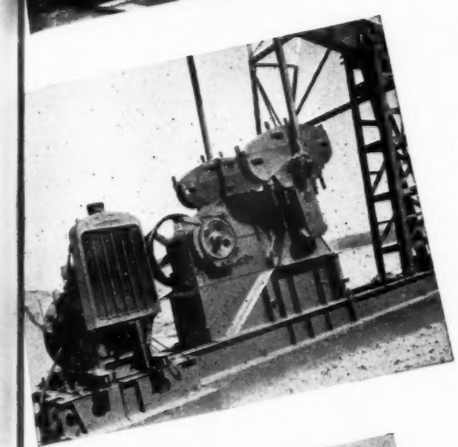
4 Four-Cylinder Sizes range from 4 hp. to 70 hp.

6 Six-Cylinder Sizes built from 30 hp. to 125 hp.









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New Drilling Rig Embodies Many Valuable Features

Portable equipment has 122-ft. mast—All-wheel-drive truck chassis supports drilling engines, drawworks, rotary table, etc.—Mud pumps, fuel tank, and light plant mounted on trailer

by H. Lee Flood

Associate Editor

AT a time when the petroleum industry is being exhorted to drill more and more wells to assure ample oil for wartime use, it is of more than passing interest to note the type of portable rig that has recently been completed and placed in operation by Shell Oil Company, Inc. Now drilling its first well, the rig is in operation at present in the Scotland field, Archer County, North Texas, approximately 15 miles south of Wichita Falls.

Many unusual features have been incorporated into the design and assembly of the drilling equipment, among the more important of which are:

1. The 122-ft. mast or derrick, by far the highest mast yet designed to be erected as a unit.
2. The all-wheel-drive truck chassis supporting the drilling engines, drawworks, rotary table, etc. Noteworthy is the absence of a conventional truck engine; motive power for the truck when changing locations is supplied by the drilling engines.
3. The trailer that serves as a permanent base for the two 7¼ by 12 mud pumps. The fuel tank and light plant are also mounted on the trailer.
4. The compact design of the flanking substructure, walkways, and pipe rack, representing virtually the only accessory equipment (other than the tool house) not permanently mounted on mobile equipment.

"Rigging-Up"

The term "rigging-up", when used to refer to the operations incidental to placing this portable rig in service, has a meaning entirely different from that generally understood a few years ago. Formerly, the time required to rig-up an old-style drilling rig was a matter of days; now the time to tear down, move, and rig-up a modern portable rig is reduced to only a few hours.

When on the road or when making a move from one location to another within a given field, the "caravan" of trucks transporting the drilling equipment will comprise the following units:

(1) The main truck, on which the engines, drawworks, table, bottom section of mast, etc., are mounted.

(2) The pump trailer pulled by a medium- or large-size oilfield truck. The trailer also carries the middle mast section during a move.

(3) An oilfield truck on which the upper section of the mast is loaded, together with the substructure.

(4) An oilfield truck on which the tool house and pipe rack are loaded.

Depending upon the distance of the move, another truck or trucks may be used to haul the drill pipe. Otherwise, on a short move, one of the above trucks may "shuttle" back and forth, making several trips to haul the various accessory equipment.

Although it will be possible to describe only one operation at a time, it should be borne in mind that many of the operations involved in rigging-up proceed simultaneously. In this way, the total time required to move and rig-up is reduced to a matter of hours.

The drilling truck, operating under power supplied by the Diesel drilling engines mounted on its bed, is

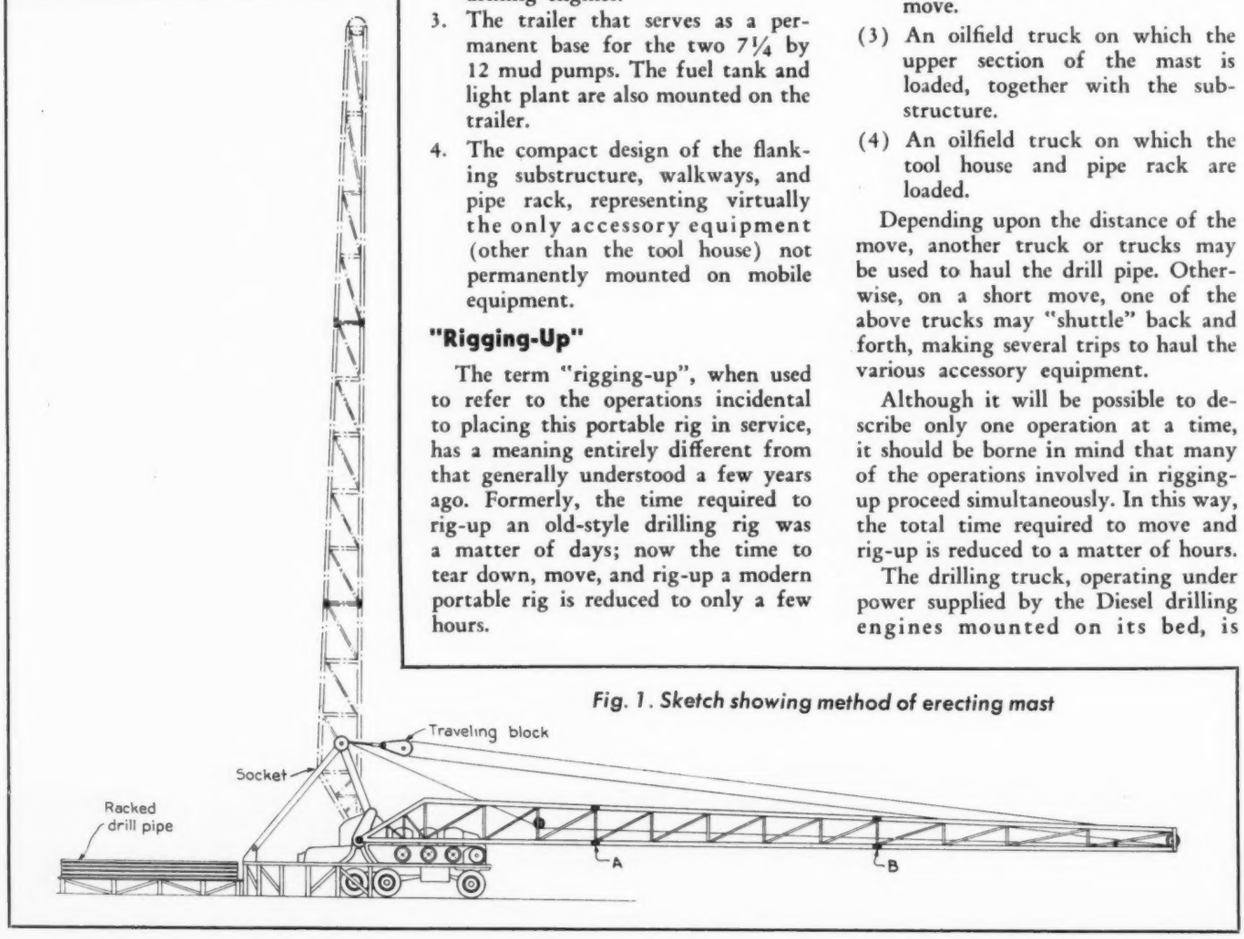

Fig. 1. Sketch showing method of erecting mast

Motion vital to DEFENSE

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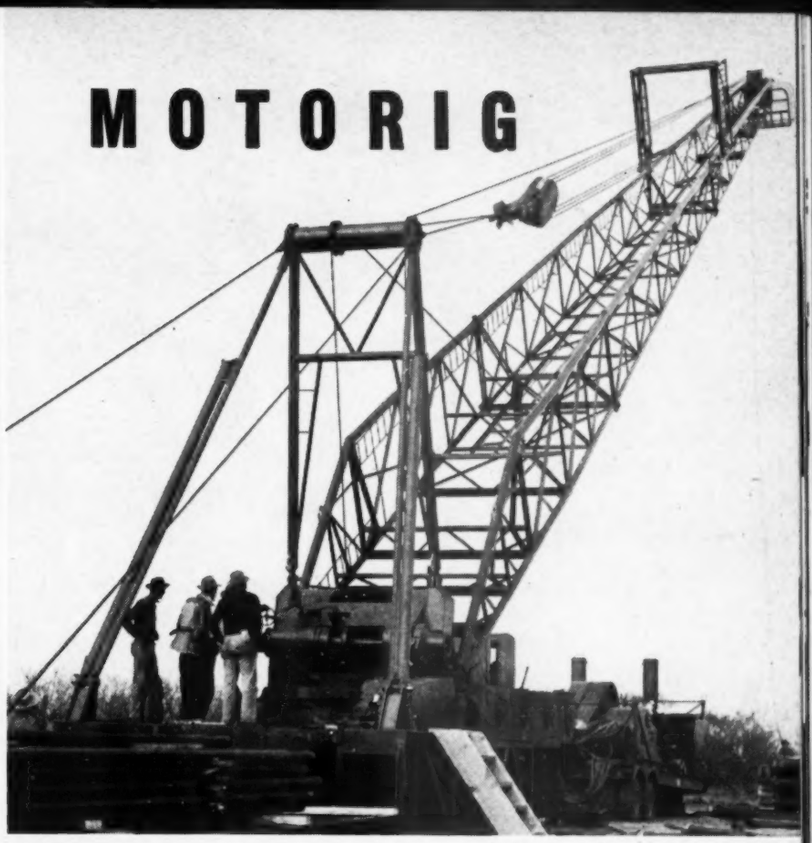
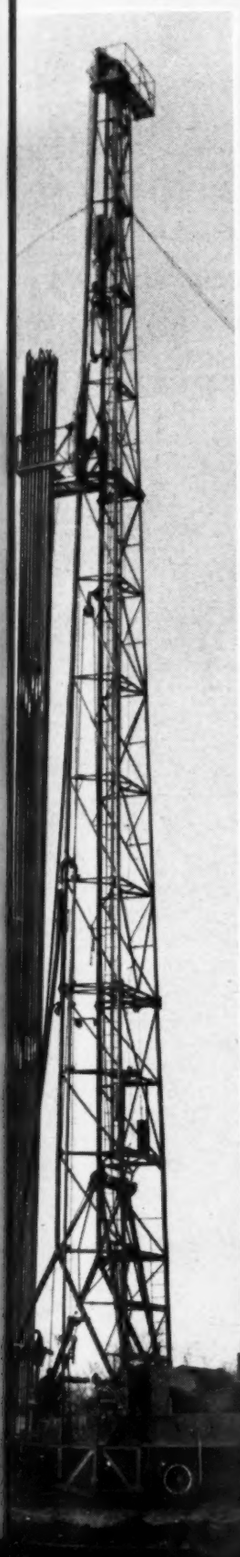




Not merely a truck-mounted rig, but a rig with all of the standard elements for drilling, from which is taken the power for propelling the truck (thus the truck requires no motor — minimizing weight and cost). There are three super charged 150 h.p. Cummins Diesel Engines.

The Motorig is equipped with Air-O-Matic clutches, patented, for driving the drum, rotary table, and slush pumps, as well as the truck. Other outstanding features are "Flexible Speed Control", Unit Rig's patented compound system, totally enclosed oil bath, 6 speed drawworks, 6 to rotary table, and 6 to drum. Oil filtering system serving both the drawworks and compound system. Unit Rig's patented automatic cathead. Catshaft located in front of unit permits more rapid operation by both the automatic cathead, and a center position spinning line cathead of friction type.

ROADABILITY

This, the world's largest mobile drilling rig, under which is placed an F. W. D. Special three axle drive running gear and its power transmission system. The power is taken from the drill rig compound to propel the truck, resulting in minimum weight and cost. On this unit is mounted the lower section of the 122 ft. tubular heavy duty cantilever mast built by Lee C. Moore & Company, Inc. The road speed of this unit is 25 mi. per hour. The center section of the mast is transported on the pump and auxiliary unit trailer. The upper section of the mast is carried by a utility truck. All three units are built within highway requirements and are highly mobile.

UNIT RIG & EQUIPMENT CO.
TULSA OKLAHOMA U.S.A.

"spotted" over the location stake. Timbers, usually 3 by 12's, are laid as tracks on which the truck wheels may rest during drilling, to afford a firm footing. Likewise, if it becomes necessary, additional timbers are placed under one or more wheels to bring the truck bed into a level position, preliminary to raising the mast. The value of all-wheel drive is clearly demonstrated when it becomes necessary to back the truck wheels over sharp timber edges. Instead of the wheels spinning and otherwise making it difficult to spot the wheels properly, the truck moves easily and quietly into position, through air-o-matic truck power input clutch, which delivers power to each of the six wheels.

When the truck is spotted properly, the wheels are locked securely. The substructure, flanking the derrick floor (rear) portion of the truck bed and serving principally as a support for the two outer legs of the A-frame, is then quickly moved into place, bolted to the truck bed, and shored-up with timbers where necessary.

During this time and as the A-frame is raised and pinned in place, the pipe racks are unloaded, assembled, and bolted to the end of the truck bed. This is an essential preliminary to raising the mast, as the weight of the racked drill pipe is depended upon as a counterbalance to offset the weight of the mast as it is raised.

As the drill-pipe is being unloaded and racked, the middle and upper sections of the mast are being assembled. In Fig. 1, the joints between the mast sections are designated as A and B.

The pump trailer carrying the middle section of the mast is backed into its position ahead of the drilling truck, thus bringing the section ends at joint A together.

The operations of coupling the trailer to the drilling truck, blocking up under truck and trailer, etc., may be conducted simultaneously with the assembly and erection of the mast.

When a short move is made in the field, the middle and upper sections of the mast may be moved together. On a long haul, the two sections are moved separately, in which case, when joint A has been bolted securely, the upper section is lifted by a boom truck until the pins on the lower two legs at joint B have been inserted. The truck then picks up the upper section, pivoting on the lower pins, until the two upper pins may be inserted.

After both joints, A and B, are completed, the traveling block is fastened to the upper part of the A-frame and the line from the drawworks drum is threaded through an auxiliary snatch

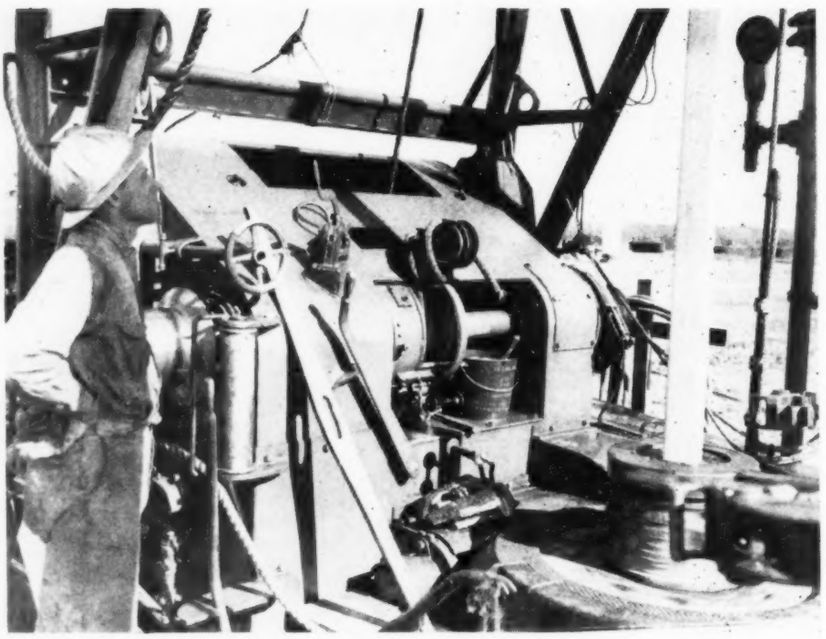
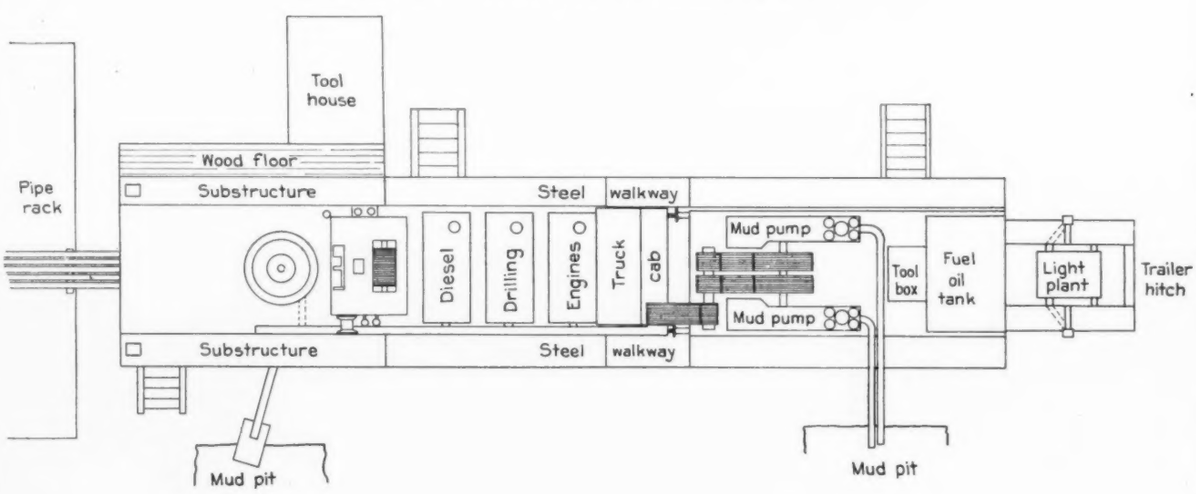
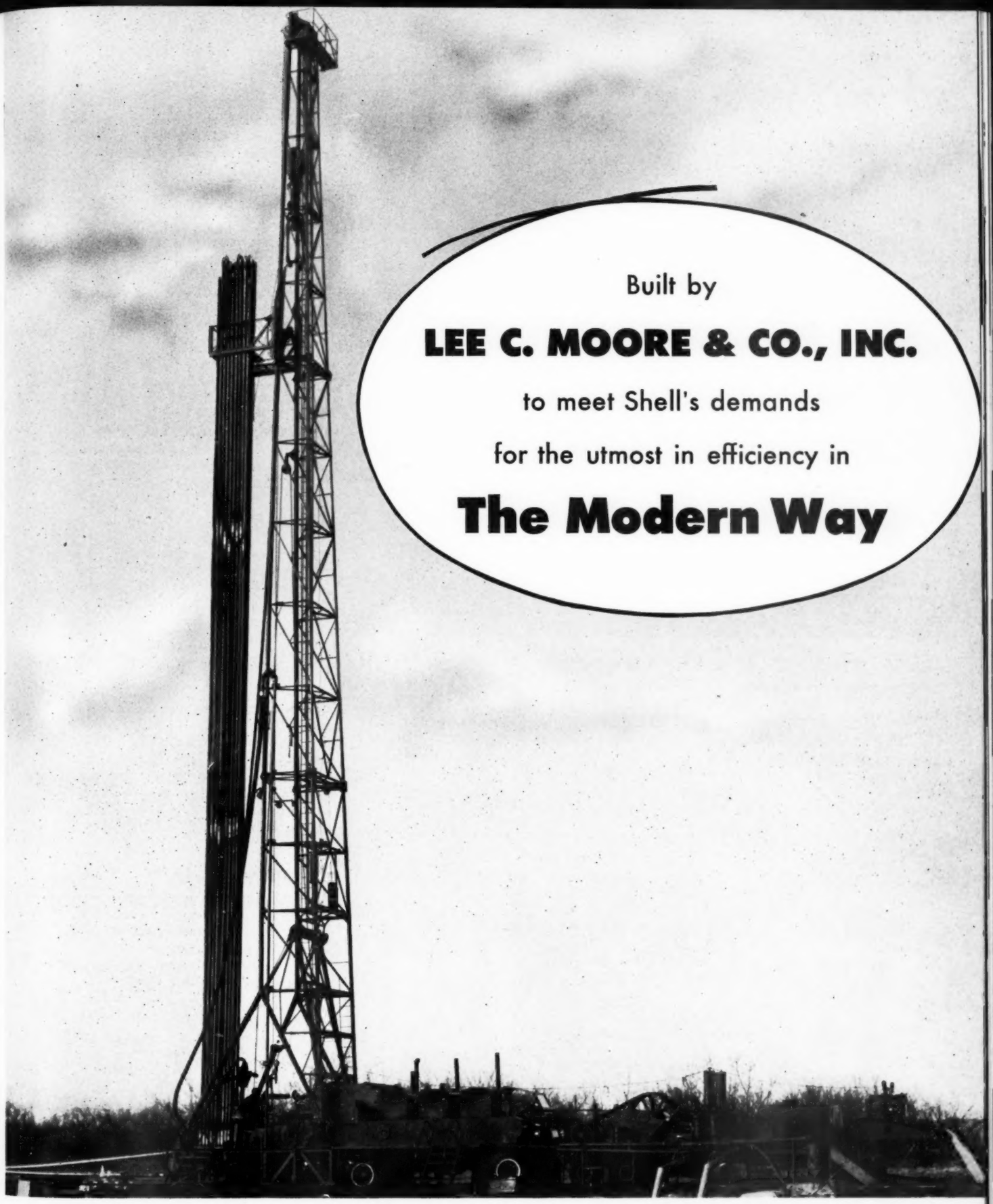


Fig. 3. Limited space on the rig floor necessitated a compact arrangement of drawworks and rotary table

Fig. 2. Top view showing layout of drilling equipment





Built by

LEE C. MOORE & CO., INC.

to meet Shell's demands

for the utmost in efficiency in

The Modern Way

THIS 120 foot tubular Cantilever type mast is made to the requirements of portability, operating strength and rugged resistance to inevitable abuse. It will handle 8,000 feet of 3½" drill pipe in thribbles. The arrangement of floor and mast is such that practically unlimited working space is attained.

These features, required by Shell, are characteristic of Lee C. Moore portable drilling and servicing masts which already have established their value in efficient use with standard type rotary rigs and hoists on skid type units.

The Lee C. Moore portable drilling mast is built in a number of sizes and capacities and is adaptable to the largest rigs.

LEE C. MOORE & CO., INC., Pittsburgh · Tulsa

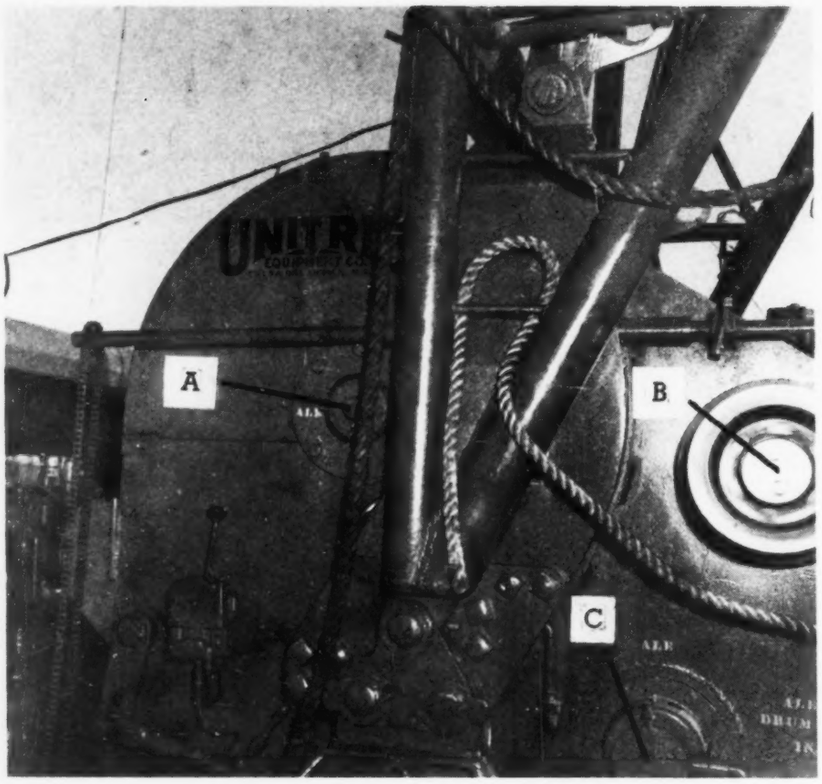


Fig. 4. Shows manner in which mast legs are pinned directly to the drawworks case

block fastened at the fifth girt of the mast. This operation requires only a few minutes, as the drilling line remains threaded between the crown and traveling blocks at all times, even during a move.

When the above operations have been completed, including the racking of the drill pipe, the mast may be quickly raised. Care is taken to assure that the lines are taut and that everything is in readiness, before a strain is taken on the line. After this, the mast is lifted without a moment's hesitation.

As the mast nears the vertical position, the drum speed is decreased and as the mast passes the point at which its weight tends to swing it forward, the brake is applied, thus permitting the mast to "ease" into its resting position against the A-frame.

Fig. 5. View of rig in operation; housing of chain power transmission from engines to drawworks and rotary table is shown in right foreground

The Mast

The design of the mast itself would make an interesting article. To attain the objective of strength using a minimum amount of steel and thus reducing the deadweight of the structure, many of the principles perfected in the design of airplanes have been incorporated.

By carefully considering the stresses within the structure and resolving the forces to attain equilibrium at each point throughout the mast, it was possible to use tubular sections of unusually small cross-section in the bracing members.

Although an A.P.I. rating cannot be applied to the mast because of its unusual construction, the structure is designed for a 280,000-lb. load. This is roughly equivalent to 8000 ft. of 3-in. drill pipe. The mast is self-supporting but guy wires are installed in accordance with the usual practice of safeguarding against high wind velocity. The weight of the mast, which does not include the substructure or A-frame, is 16,000 lb.

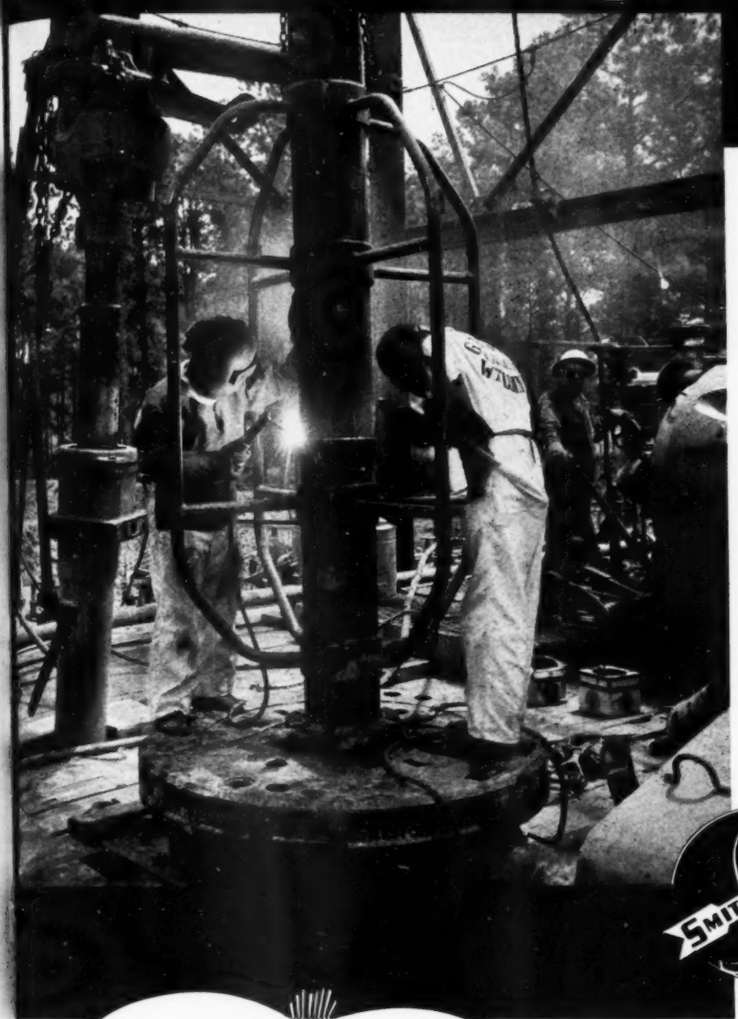
Drawworks and Engines

The layout of the drawworks and drilling engines in this assembly represents what is probably one of the most compact arrangements yet devised in the development of lightweight, portable drilling rigs.

Several of the accompanying photographs present a graphic picture of the manner in which the equipment has been designed to conserve space and still provide enough room for the drilling crew to operate.

Perhaps the outstanding achievement in assembling the equipment is the redesign of the drawworks itself. To conform with the limited space requirements, a standard model drawworks (of a type that is used extensively for medium depth drilling in many fields) was virtually "up-ended". Instead of being behind the drumshaft, the catshaft and rotary drive countershaft have been moved forward, as shown in Fig. 3. Because the rotary

SMITH *Single-bell Casing*



Welded String Costs 6.89% Less Than Equivalent Threaded and Coupled String

● By running a 1,634.89-ft. surface string of 10¾", 38.87-lb. Single-bell, Smith-40 Casing, the major oil company which owns this Texas Gulf Coast well saved $213.52—6.89% of the $3,099.91 installed cost of an equivalent Smith threaded and coupled string. The Gardner Welding Service charge was, of course, included in the Single-bell casing installation cost used in this comparison.

That is saving No. 1. Saving No. 2 resulted from the fact that Smith Casing, whether SB or T&C, uses *less steel* to achieve equal or greater safety factors. An exclusive process increases the collapse resistance of Smith Casing without increasing its weight. And Smith Casing specifications are based not on averages but on reliable *minimum* safety factors which are *test-proved for each length* during manufacture.

By meeting safety factor requirements with less weight, Smith Casing not only saves you money, but also *conserves vitally needed steel.* That's something to remember when steel is available for filling your casing orders. A. O. Smith Corporation, Milwaukee, Wis. Offices at New York, Pittsburgh, Chicago, Tulsa, Dallas, Shreveport, Houston, Corpus Christi, Midland, Los Angeles, Seattle.

SMITH way

DID YOU KNOW?

- That A. O. Smith Corporation was founded at Milwaukee, Wisconsin, in 1874, only *three years after the great Chicago fire.*
- That during the 67 years of its existence, A. O. Smith has pioneered in developing new, faster, more economical methods of manufacturing better, more safely used steel products.
- That A. O. Smith made the *first pressed steel auto frame,* originated modern, dependable welding, first produced *welded pressure vessels,* and revolutionized pipe line building with *high-strength welded line pipe.*

A.O.SMITH
CORPORATION
Milwaukee, Wisconsin

MANUFACTURERS OF ELECTRIC-WELDED

Casing

Pressure Vessels • Line Pipe

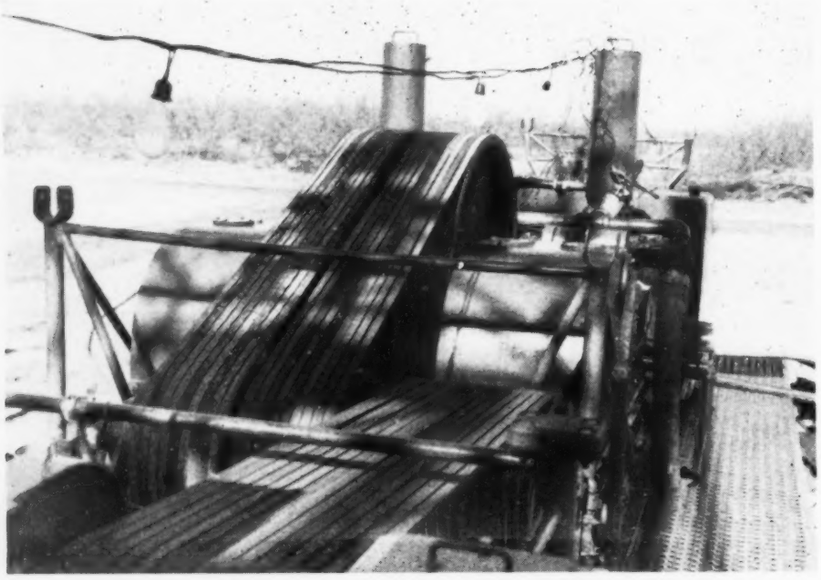


Fig. 6. V-belt power transmission from Diesel engines to mud pumps

table is so near the drawworks, the automatic cathead is mounted in the center of the catshaft. The lever controlling the cathead clutch is placed conveniently on the drawworks case, within easy reach of the driller.

Fig. 4, which shows principally how the mast legs are pinned directly to the drawworks case, indicates the relative positions of the drawworks shafts. "A" is the drumshaft, "B" the catshaft, and "C" the rotary drive countershaft. It is to be noted also that all grease fittings are clearly marked by the stenciled letters "ALE" at all points throughout the rig, so that there will be less risk of overlooking a fitting. As all shafts are mounted on large capacity self-aligning roller bearings, it is important that these bearings be well-lubricated in order to contribute to lengthening the life of the equipment and to insuring trouble-free operation.

The chain transmission, which transmits power from the engines to the drawworks, is completely housed as shown in Fig. 5.

The three engines are full Diesels, each having a rating of 150 hp., a total of 450 hp. for the rig. A V-belt sheave mounted alongside the truck cab provides the power take-off for the mud pumps on the trailer, as shown in Fig. 6.

Mud Pumps

Width of the pump base was an important specification in order to meet the requirement of mounting two pumps side by side without exceeding a total width of 8 ft. It is obvious, however, that the pump selected should be rugged and durable, in addition to being compact, in order to function satisfactorily.

The pumps selected, shown in Fig. 6, have a 12-in. stroke. The pressures available with various sizes of interchangeable liners are as follows:

Diameter of lines, inches	Maximum pressure, lb. per sq. in.
7¼	450
6¾	525
6	665
5½	790
5	995
4½	1180

The drive from the engines to the pump countershaft has 14 V-belts, and that to each pump from the countershaft, 9 V-belts.

Operation of Rig

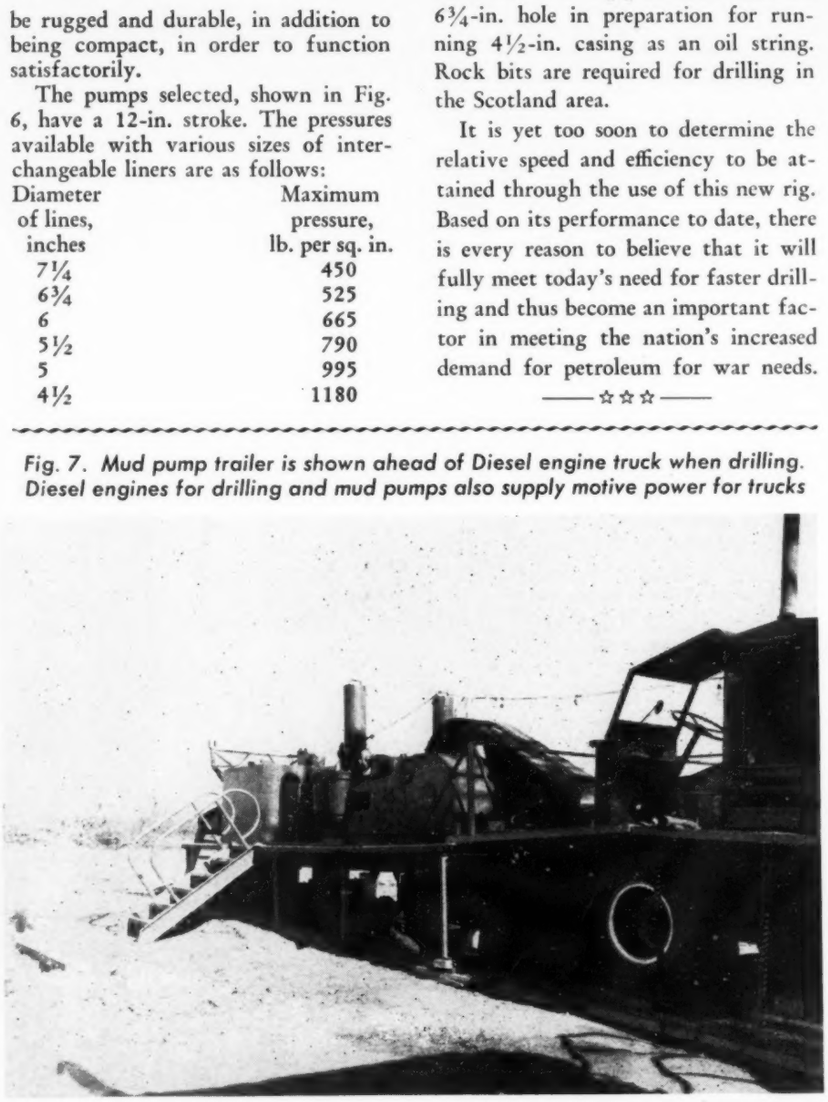
In witnessing the rig's performance on the first well it has drilled, it is interesting to note how quickly the drilling crews have learned to operate the equipment. Several of the crew members had never worked on a portable rig before. Accustomed as they have been to working on the relatively spacious floor of larger rigs, it requires a little time for them to learn to conserve their movement and work efficiently in the more limited area.

The 3-in. drill pipe joints used with the rig are equipped with box ends, requiring the use of double pin tool joint "subs" that lend themselves so readily to re-sleeving when they become worn. This pipe is used to drill a 6¾-in. hole in preparation for running 4½-in. casing as an oil string. Rock bits are required for drilling in the Scotland area.

It is yet too soon to determine the relative speed and efficiency to be attained through the use of this new rig. Based on its performance to date, there is every reason to believe that it will fully meet today's need for faster drilling and thus become an important factor in meeting the nation's increased demand for petroleum for war needs.

——☆☆☆——

Fig. 7. Mud pump trailer is shown ahead of Diesel engine truck when drilling. Diesel engines for drilling and mud pumps also supply motive power for trucks



We've come a long way since '17 . . . .

. . . On June 3, 1917, two engineers locked in a Washington hotel room started working out plans for a new military aircraft engine. On July 3 the 8-cylinder engine, assembled from parts made in 12 plants from Connecticut to California, was ready for test—then, because war experience indicated more power was essential, was redesigned into the famous 12-cylinder "Liberty." By the end of the war, 15,000 of these engines had been built. Weighing 825 lbs. and developing 380 to 430 HP, with mean effective pressures of 115 lbs./sq. in., and fuel consumption of .52 lb./HPH, this engine was a remarkable tribute to American ingenuity and American production methods. In the "Liberty," as in leading aircraft engines today, American Hammered Piston Rings were used.

Like Aircraft Engines, Diesels have come a long way since '17. Each new development has made new and greater demands on the piston rings. Koppers engineers, working closely with engine builders and backed by complete facilities and a highly skilled manufacturing personnel, have kept ring performance in continuous step with engine performance. Today, as in '17, you'll generally find star performers are "American Hammered" equipped.

American Hammered Piston Rings

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Send this coupon for free literature from the Koppers Library of Technical Information.

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Safety in Small Plants Pays Big Dividends

☆ **Safety practices need not be limited to large plants—Part-time attention directed to stimulating interest of foremen and workmen is shown to bring results**

by Don Attaway

Safety Engineer, Arkansas Fuel Oil Company

DON ATTAWAY

began his career with the Dixie Gulf Gas Company as timekeeper in the Waskom district, January, 1928—Entered the payroll department of United Gas Company late in 1929 and worked there until he accepted a position with Arkansas Fuel Oil Company in September, 1930, in the gas accounting department—Worked successively as meter man, loading rack man, and utility man in the East Texas natural gasoline plant—Later was transferred to the Shreveport gasoline plant—In January, 1940, he was made safety engineer for the company—His headquarters are in Shreveport, Louisiana.

THE newspapers and other sources of information have made us acutely aware of the tremendous time losses in national industry due to strikes. According to the U. S. Department of Labor, a total of 6,700,000 man days of idleness was caused by strikes during 1940. One can almost gasp at this tremendous amount of lost time.

If this is amazing then many persons will almost be jolted from their seats to learn that accidents cost us *four times* as much lost time as strikes. During 1940 a total of 26,000,000 man days was lost due to mishaps. This does not take into account the time chargeable to deaths and total-permanent disabilities. If we were to count these charges, the figure becomes 169,000,000 lost days or twenty times greater than the time lost by strikes.

These are, indeed, stunning figures and are difficult to grasp for comparison. But it is evident that in our war emergency today, there is a crying need for the collective labor of all our people and a vigor in our accident prevention programs. In a nation such as ours with the heavy demand upon manpower that world conditions have created, safety and health of employees take on added value. A part of our industrial production is turned out by large centralized companies that, by reason of their size, can look after the safety and health of their workmen by inaugurating and maintaining safety and personnel departments staffed by trained men from the field. In such cases, splendid results are obtained in accident prevention.

The greater part of our national producing capacity, however, is in the small plants and few, if any, are in a position to maintain a safety or health department. In these small plants accidents strike most frequently and severely. It is in these countless small plants in the aggregate that the accident factor cuts so deeply into the nation's production.

The present article will deal in general with safety and health habits in these small plants and specifically with the practices and procedures that have been successfully applied by one department of a large organization responsible for operating several small plants.

Case History

The natural gasoline department of the Arkansas Fuel Oil Company is comprised of nine plants situated in the states of Louisiana and Texas, and employing a total of between 150 and 200 men. These plants as units are small and somewhat scattered. The largest plant employs 35 men and the smallest plant is operated by 8 men.

During the year 1938, the department accident record showed a total of 40 accidents with 6 of them being lost-time injuries. In the year following, the accident experience was even worse. A total of 53 accidents was reported with 12 lost-time injuries. These accidents were expensive. Accordingly, insurance premiums increased materially. It was even more apparent that these accidents were a needless expense and that an important saving could be realized if they were eliminated. At the same time, it was recognized that these trained employees being injured were valuable to the company, and the loss of their skill and experience for any period of time was reflected in impaired operating efficiency. Added to these conditions was the fact that accidents caused pain and suffering that no amount of compensation could relieve, and disabilities incurred that future years could not erase.

Upon consideration of these facts, an accident prevention campaign was launched in the department. The success of the campaign that followed can be attributed in great part to the fact that the active coöperation and leadership of the chief operating official provided the support needed to produce the desired results from the foremen and superintendents. This is the first rule in any safety program. To succeed it must originate from top management and possesss official leadership.

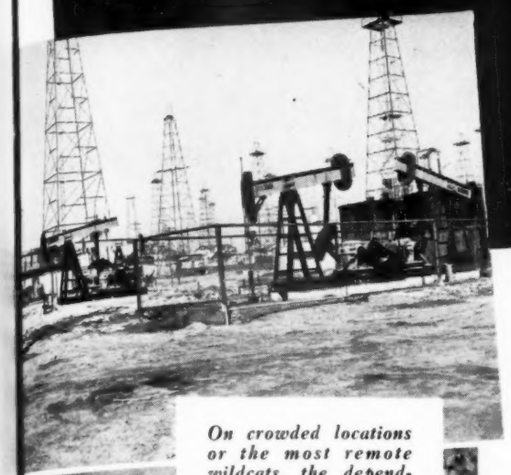
First Step in Campaign

In January, 1940, a safety inspector or engineer was appointed for the department and monthly plant inspections originated. This first step consisted of the safety man visiting each plant and personally inspecting the equipment and personnel. A report form was drawn up that listed each piece of equipment or unit in the plant. For example, the first item on the report was "absorbers" and under that heading blank lines were inserted for the inspector to note actual condition of the units under that designation. In alphabetical order the other plant units followed and the report closed with a General Summary.

The purpose of this report was to record any and all unsafe or hazardous operating conditions for the consideration of the department head and individual plant superintendent. In cases where certain conditions were extremely hazardous or of such nature that they could be corrected without a large cash outlay, the attention of the superintendent was called by means of a personal letter from the department head.

In view of the fact that the department only consisted of nine plants, it can be readily seen that the safety in-

DEPENDABILITY ASSURED BY SOUND DESIGN



On crowded locations or the most remote wildcats, the dependability of "Oilwell" Pumping Units is a more important advantage than ever before.

WHY "OILWELL" PUMPING UNITS ARE DEPENDABLE

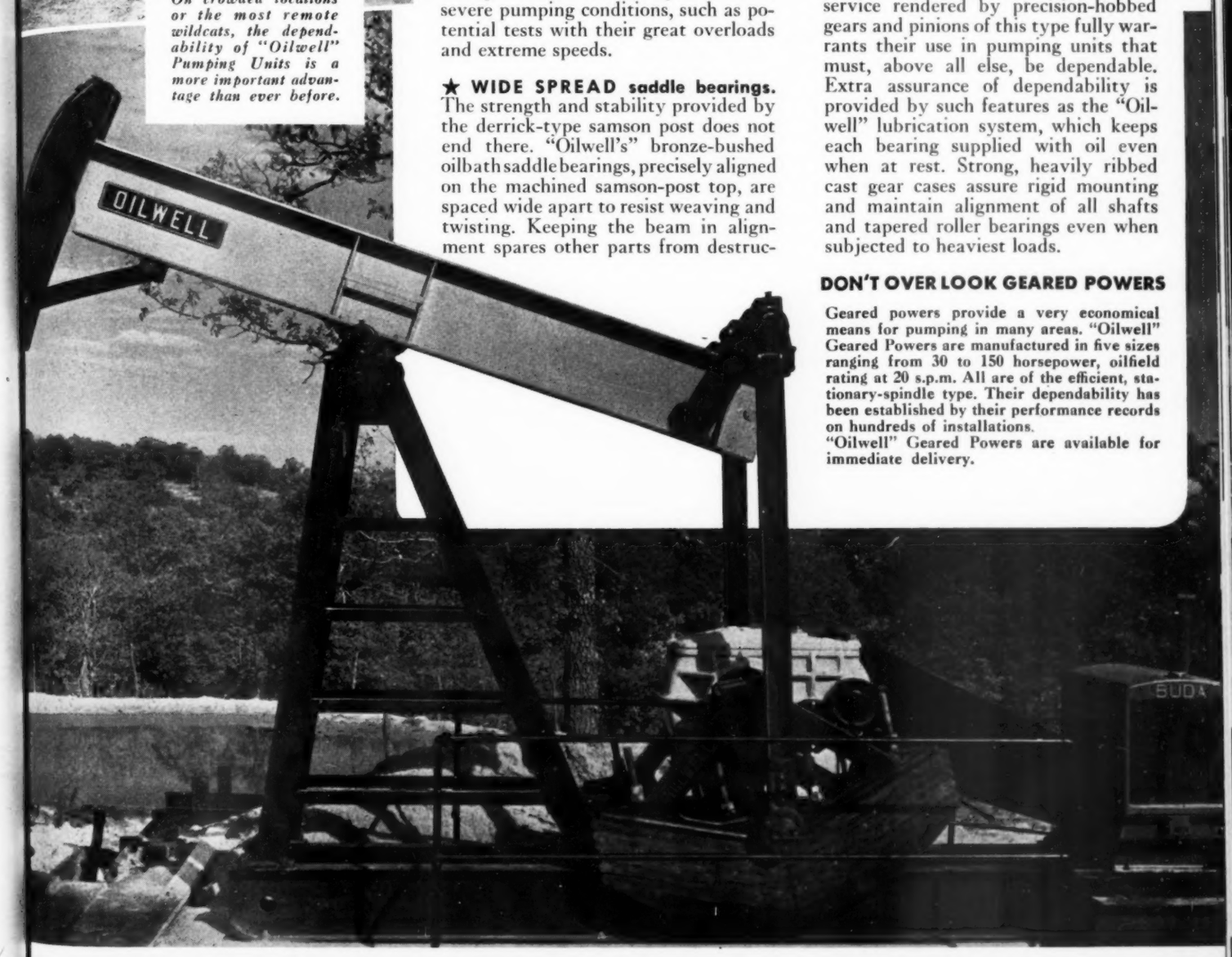
★ **RIGID, 4-leg, derrick-type samson posts.** "Oilwell" started using this construction in 1931 after long experience with other types. This construction has been proved under a variety of the most severe pumping conditions, such as potential tests with their great overloads and extreme speeds.

★ **WIDE SPREAD saddle bearings.** The strength and stability provided by the derrick-type samson post does not end there. "Oilwell's" bronze-bushed oilbath saddle bearings, precisely aligned on the machined samson-post top, are spaced wide apart to resist weaving and twisting. Keeping the beam in alignment spares other parts from destructive side thrusts and strains which tend to shorten efficient service life.

★ **FULLY heat-treated, single-helical gears and pinions.** The long, efficient service rendered by precision-hobbed gears and pinions of this type fully warrants their use in pumping units that must, above all else, be dependable. Extra assurance of dependability is provided by such features as the "Oilwell" lubrication system, which keeps each bearing supplied with oil even when at rest. Strong, heavily ribbed cast gear cases assure rigid mounting and maintain alignment of all shafts and tapered roller bearings even when subjected to heaviest loads.

DON'T OVER LOOK GEARED POWERS

Geared powers provide a very economical means for pumping in many areas. "Oilwell" Geared Powers are manufactured in five sizes ranging from 30 to 150 horsepower, oilfield rating at 20 s.p.m. All are of the efficient, stationary-spindle type. Their dependability has been established by their performance records on hundreds of installations.
"Oilwell" Geared Powers are available for immediate delivery.



OIL WELL SUPPLY COMPANY

spector was only occupied in this task for nine days of the month, leaving the balance of his time for attention to other duties such as field testing, home plant operations, or such duties as were required in normal operation.

Experience of other safety organizations has proved that the same principles that have been followed successfully in advertising commodities to the buying public will produce comparable results, if followed closely in advertising safety to employees. The main job of our campaign, of course, was to sell safety to the men on the job and as we were in no position to maintain what might be called "a traveling salesman," the utilization of posters and pamphlets was considered and some study given to the means of presenting frequent safety messages as a constant reminder that the management had not lost interest in the maintenance of safe practices.

Second Step

After due consideration, the second step in the campaign was made by the creation of a safety pamphlet to be issued once each month and attached to the employee's mid-month pay check. This pamphlet was entitled *The Safety Sentinel* and edited by the safety inspector. It was produced by mimeograph on ordinary 8½ by 11 paper and laid out so that a single fold produced a 4-page booklet. The contents of this publication was made up from safety bulletin clippings, operating instructions from equipment manufacturers, contributions from employees, and safe practice manuals.

After the development of the monthly pamphlet, a subscription was entered for a poster service from one of the national safety organizations and these posters erected and frequently changed by the safety engineer on his monthly visits to the plant. Accordingly the posters could be rotated from plant to plant and fewer were required. It was found that the display of posters required fitting the message of the poster to the unit or installation where the potential hazard was present. For example, posters dealing with eye injuries or the use of goggles, were found to be more valuable if displayed near the grinder or emery wheel. Posters dealing with safe procedure in boiler operation found more interest when placed on a bulletin board in the boiler house, and good housekeeping safety messages produced better results when displayed in the warehouse or engine room.

Fig. 1A. Form used by safety inspector

SAFETY INSPECTION REPORT Page 1

_____ Plant. Date _____, 19____.

Equipment

Absorbers _____

Boilers and Boiler House _____

Cottages _____

Coolers and Condensers _____

Cooling Tower _____

Compressors and Compressor Building _____

Distillation Units _____

Exchangers and Preheaters _____

Electrical Generator and Wiring _____

Field Gathering Lines _____

Laboratory and Office _____

Creating Competitive Spirit

To create something of a competitive spirit among the plants, the management offered a reward in the form of a large, all-wool American flag to each plant that completed 6 months of no-lost-time operation. Every plant in the department qualified for this award and suitable poles were erected for the display of the flag.

To add weight to the value of advertising safety to the men, large metal signs, 20 in. by 24 in., bearing the wording "THIS PLANT HAS WORKED ..... DAYS WITHOUT A LOST-TIME ACCIDENT" were obtained and erected at each plant. In the blank space in the wording was posted the number of safe operating days and this figure was kept up-to-date as the plant continued its record. A desire to keep an unblemished record was stimulated among the workmen and many of these plants have their safety record intact.

In plants where inherent hazards exist, metal precautionary signs were obtained bearing warning or information concerning the hazard and these signs prominently displayed. In other spots, permanent safety signs such as "NO SMOKING" and "SAFETY FIRST" were erected.

The "advertising" done by the methods described above was carried on at only small cost, yet the results obtained were tremendous. It might be truly said that the safety advertising done throughout the department during the campaign was the next largest factor to management interest in the ultimate success obtained.

It was evident early in the program that the amount of sincere interest evidenced among the employees was reflected by the foreman's or superintendent's attitude toward safety. Unless the foreman and superintendent made every possible effort to provide safe working conditions and safe practices for the men, little attention would have been given to precaution by the working force. Fortunately, the selling of safety by advertising had been well done. As an example, the superintendents authorized the purchase of goggles for the employees to use in work exposing them to eye injury. Foremen and supervisors encouraged their use. A review of the department accident rec-

How Chromium Steels

help to speed up refinery operations

CHROMIUM steels are resistant to corrosion and oxidation, and have high strength and hardness even at elevated temperatures. Because of this combination of properties, the use of chromium steels in oil refinery equipment keeps costly and time-consuming shutdowns for repair and replacement at a minimum and makes for fast, uninterrupted, economical operation.

The 4 to 6 per cent chromium steels are used for tubes, pump bodies, and transfer lines; the 12 to 14 per cent chromium steels for reaction chamber liners, pump parts, and valves; the 18-8 chromium-nickel stainless steels for distillation equipment, including trays, bubble caps, header boxes, and valves; and the 25-12 chromium-nickel steels for furnace parts, fractionating towers, and other applications where resistance to high temperatures is involved. The illustrations show a few applications which may suggest where you can use chromium steels to speed up production of petroleum products essential to National Defense.

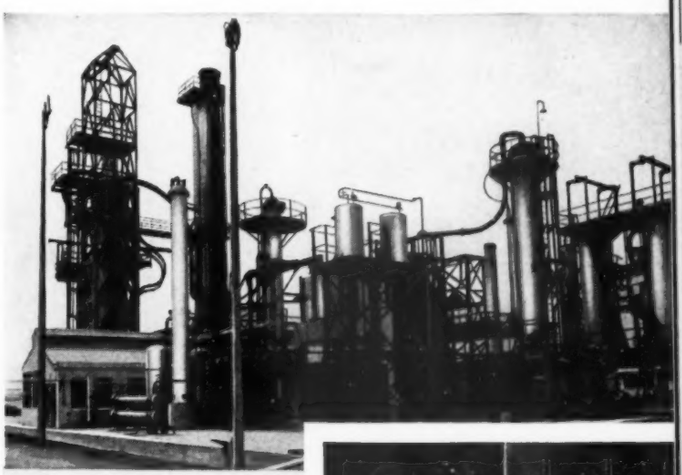
We do not make steel of any kind, but we have for over 35 years produced "Electromet" ferro-alloys used in making steel. With the knowledge accumulated from this experience, we are in a position to give you, without obligation, impartial assistance in the selection of a chromium steel to suit your particular needs.

ELECTRO METALLURGICAL COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York, N. Y.

In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario



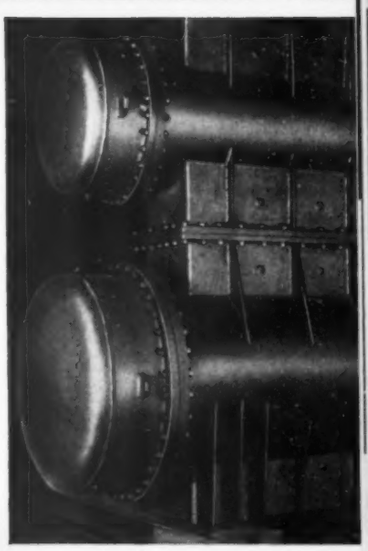
Above: Cracking still tubes of 18-8 chromium-nickel stainless steel withstand high temperatures and pressures.

•

Right: The 4 to 6 per cent chromium steels containing a small amount of molybdenum are being used for heat exchanger tubes and condenser pipe.

•

Below: Vessels lined with 12 per cent chromium steel withstand corrosion, and save weight.



4 — 6% Chromium Steels

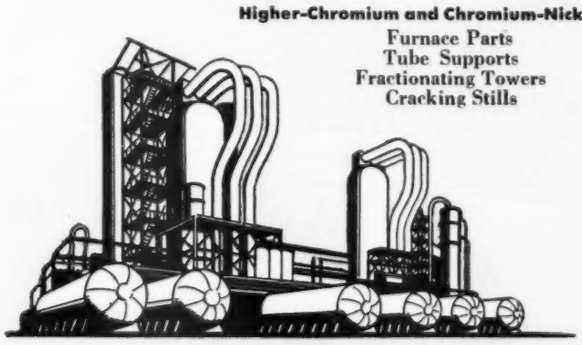
Tubes
Pump Bodies
Transfer Lines
Valve Bodies
Fittings
Return Bends
Preheaters

12 — 14% Chromium and 18-8 Chromium-Nickel Stainless Steels

Reaction Chambers
Oil Still Tubes
Distillation Equipment
Valves
Fittings
Header Boxes

Higher-Chromium and Chromium-Nickel Steels

Furnace Parts
Tube Supports
Fractionating Towers
Cracking Stills



SOME USES OF CHROMIUM STEELS IN OIL REFINERIES

Electromet
Trade Mark
Ferro-Alloys & Metals

ords of 1938 and 1939 showed that injuries to eyes, hands, and feet dominated the report.

Having provided the eye protection, steps were taken to encourage the men to purchase and wear safety shoes. This work was fairly successful and the majority of the men in operations exposing the feet voluntarily purchased shoes equipped with safety toes.

Among the other safety equipment purchased by the company was an explosimeter or gas-testing device for determining the presence of inflammable vapors in any vessel or piece of equipment about to be welded or exposed to open flame. For the testing and checking of pressure gauges on equipment, a deadweight tester was purchased and all gauges are now checked periodically for accuracy.

Campaign Results

At the close of the first year of the accident prevention campaign a look was taken at the record. The results were amazing. In view of the very nature of the business and the amount of construction continually in progress, as well as the unusual labor turnover due to other causes, nothing like a perfect record was expected. It was hoped that a marked decline in accidents would be achieved. No one was optimistic enough to venture a guess that the department would operate an entire year with only one lost-time accident. But that is what happened!

In 1940 a total of more than 330,000 man hours was worked with only one lost-time accident that accounted for 16 days. Comparing this record with the last year of "no safety" operation, we find that in 1939 the record reports 53 accidents with 12 of them lost-time injuries. One of these resulted in a man's death. Another man was seriously injured. Two were painfully hurt and one spent 4 days under a doctor's care. A total of 6268 lost days was charged to the 1939 operations.

These results were so convincing that our safety efforts were redoubled. With 22 accidents reported for 1940 compared against the 53 reported in 1939, we were convinced our safety efforts had been more than doubly rewarded.

Here was the concrete evidence of what could be done by part time attention of a safety engineer coupled with safety advertising and management support.

But we were still having some accidents, as the report shows 22 mishaps. Consequently, early in 1941 our safety work was expanded by the adoption of accident investigations in an effort to determine the cause of the accidents that were recorded. This work consisted of the safety inspector visiting the scene of an accident as soon as possible after the occurrence, and questioning the injured man and witnesses, if any. This was done to determine whether the cause was an unsafe act or a mechanical or physical hazard. If the accident was an unsafe act, then the employee was instructed as to the correct procedure to prevent a recurrence. If a physical or mechanical hazard was found, the matter was taken up with the foreman or superintendent in charge in order to work out a solution that might eliminate the hazard.

Such investigations coupled with the plant inspection uncovered hazards like mushroomed chisels, broken sledge-hammer handles, open gate valve boxes, exposed steam lines, and cracked or sprung wrenches. These were speedily replaced with new equipment or properly safeguarded. Among the unsafe acts determined were mis-use of tools, unsafe and incorrect lifting, and wrong working procedure. In these cases, the safety inspector informed the employee of the safe practice required and published a list of the rules, covering the condition causing the accident, in the next issue of *The Safety Sentinel*.

A check-up on the value of the safety pamphlet was made and it was found that operating forces were reading the booklet and discussing among themselves the suggestions and safety rules published in the booklet. This survey was made by questioning the men concerning certain information appearing in the pamphlet and noting whether or not the booklets were discarded in waste baskets, junk cans, or containers located within the plant. Only two discarded pamphlets were found on the first survey taken.

Another extension of the safety work for 1941 consisted of an inventory of the fire-fighting equipment provided on the plant sites. It was found that certain areas were without adequate or proper type extinguishers. In other plants the extinguishers were badly placed and required relocating. These conditions were quickly remedied by the purchase of suitable and proper equipment and correctly locating the existing equipment. It can be said that the savings accomplished by the 1940

Fig. 1B. Form used by safety inspector

SAFETY INSPECTION REPORT — Page 2

_____ Plant. Date _____, 19____.

Loading Rack _____

Meters _____

Meter Runs _____

Pump Room and Building _____

Relief Valves and Regulators _____

Steam Pumps and Turbines _____

Steam Traps and Lines _____

Scrubbers _____

Stabilizer Unit _____

Storage and Tanks _____

Tools _____

Warehouse and Building _____

General

Signed _____

Only 8 of 17 Points for:

HAZARD LAY·SET *Preformed*

PREFORMED WIRE ROPE

4. The load on a PREFORMED wire rope is distributed equally to each strand, and to each wire in every strand. The rope is safer under load, lasts longer and maintains the safety factor better.
5. When outer wires break they do not stand up from the surface of the rope to injure workmen, sheaves and the rope itself.
6. PREFORMED wire ropes are installed with greater ease and in shorter time.
7. PREFORMED wire ropes are "pre-broken-in."
8. PREFORMED wire ropes, in stretching, do not suffer change in length of lay. Strands are merely bedded firmly to the core.
9. PREFORMED wire ropes do not rotate in the sheaves to the same extent as non-preformed ropes.
10. PREFORMED wire ropes resist the whipping associated with vibration.
11. PREFORMED wire ropes permit more "fool proof" attachment of sockets, helping workmen to attach the sockets without unbalancing the rope lays below the socket bases.

Worn PREFORMED wire rope is safer to handle — does not "porcupine" — men handle it faster

PAGE 87

This is a page reproduced from the MODERN WIRE ROPE DIGEST *—America's No. 1 authority on wire rope, its manufacture, construction, care and use. It lists 17 points of superiority for the preformed type of wire rope.*

● Being preformed (and the *first* rope to be preformed under the assigned patents) Hazard LAY-SET has repeatedly proved up on all seventeen points in practically all applications. LAY-SET PREFORMED is backed by 96 years of rope-making experience and by a company that has clung so tenaciously to quality materials, manufacture and service that it has on its books many firms who have used Hazard ropes continuously for 40, 50 and 60 years. All Hazard ropes identified by the Green Strand are made of Improved Plow Steel.

HAZARD WIRE ROPE DIVISION
WILKES-BARRE, PENNSYLVANIA
AMERICAN CHAIN & CABLE COMPANY, INC., BRIDGEPORT, CONN.
Branches or Distributors in All Important Oil Fields

GREEN SIGNIFIES SAFETY

HAZARD LAY·SET *Preformed* ROTARY LINES

safety work was more than enough to pay for the new equipment purchased.

After purchasing new extinguishers of more modern design and adopting different operating procedures, the safety inspector adopted a plan of having the employees learn the proper use of the extinguishers by actually starting fires at a safe spot near or beyond the plant and allowing the workman to extinguish the flame. Certain type extinguishers that require refilling yearly were used in most of these demonstrations and the employee received actual fire-fighting experience as well as working knowledge of the equipment by recharging the vessel and noting its construction.

These experiments or demonstrations were made during the monthly inspection trip to the plant and at such times as the extinguishers were due for recharging, thus eliminating any additional cost to normal operations.

The final improvement of the 1941 safety campaign was the direction of attention to the employees' health. Sanitary individual paper drinking cups were supplied at fountains and coolers, and salt tablet dispensers installed. Washroom facilities and water closets were improved and an appeal made to the men to watch their health habits more closely. First aid kits were purchased for each plant and well stocked. First aid pamphlets containing essential information for employees on the job and at home were distributed. These pamphlets were obtained from one of the leading insurance companies at no expense.

It might be well to remark that our accident prevention campaign did not lay stress upon safety meetings for the employees. This policy is best explained by the fact that our plants have small working forces. As mentioned earlier in the article, as few as 8 men operate certain plants. The operating force works in three shifts and it would be almost impossible to gather these men without some of them having to sacrifice their rest period or neglect their operation duties.

According to methods laid down by the National Safety Council, the statistics of accident experience can be computed in terms of frequency and severity. The formula for establishing accident frequency is:

$$\text{Frequency} = \frac{\text{Number of lost-time accidents} \times 1{,}000{,}000}{\text{Total man-hours worked}}$$

This would, of course express number of lost-time accidents per million man-hours worked. The formula for severity of an accident is:

$$\text{Severity} = \frac{\text{Number of lost-time days} \times 1000}{\text{Total man-hours worked}}$$

This result would reveal the intensity of the accident compared to each 1000 man-hours worked.

This information is a yardstick for studying accident experience and can be used to many advantages. In order to better understand the progress made by this department, a comparison of the frequency and severity by years can be made that will show the following:

Year	*Frequency*	*Severity*
1939	36.42	20.83
1940	24.66	1.24
1941	3.88	0.10 (9 months)

Even a quick glance will show that the improvement is remarkable. Today the natural gasoline department of the Arkansas Fuel Oil Company ranks first with four other natural gasoline departments in the nation, all having perfect records.

The obvious conclusion is that accidents can be prevented and that safety work can be carried on in small plants and by small companies with only part-time effort and little expense. If the management of the small company or plant is willing to back the safety campaign, it can be made to work through education, engineering, and enforcement. Our campaign was based primarily on official leadership, selling the safety idea to the employees through advertising, promoting the coöperation of foremen and superintendents, and providing safety equipment and encouraging its use.

Not only did our safety campaign reduce suffering and pain, but it actually made money for us. It can do the same for you.

☆☆☆

Fig. 2. A safety bulletin can do much to hold interest in working safely

THE
SAFETY SENTINEL

Published for the Employees of the
Natural Gasoline Division of the Arkansas Fuel Oil Company

VOL. 2 NOVEMBER, 1941. No. 11

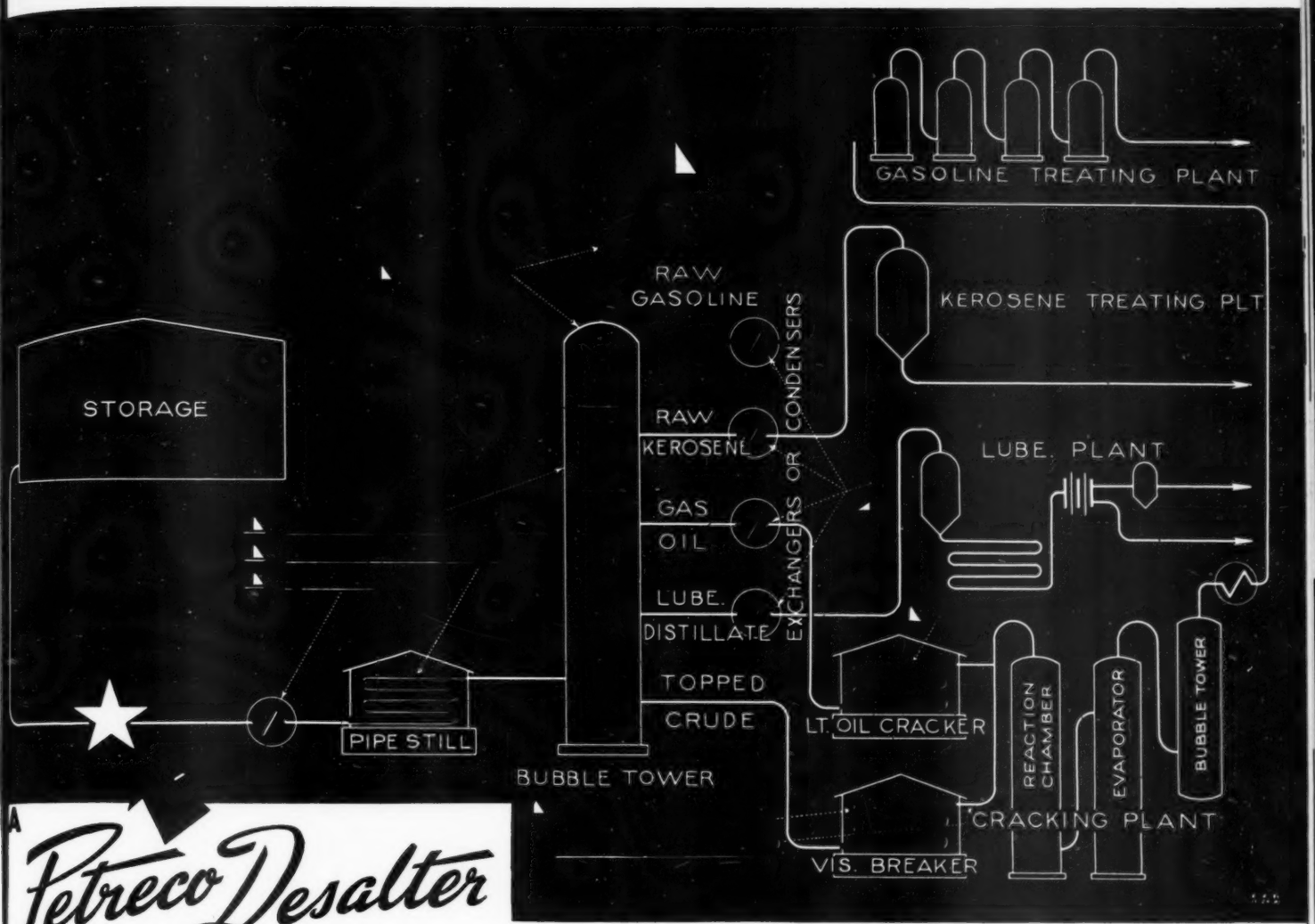
HEALTH FIRST!
****

Most men feel pretty lucky as long as they have their health, but few do anything about keeping in good physical condition.

In a country such as ours with a mighty demand upon man-power, health takes on added value. A great part of our industrial production is turned out by the large centralized companies which, by reason of their size can look after the health of their men. The greater part of our producing capacity, however, is in the small plants and few of them are in a position to maintain a health program.

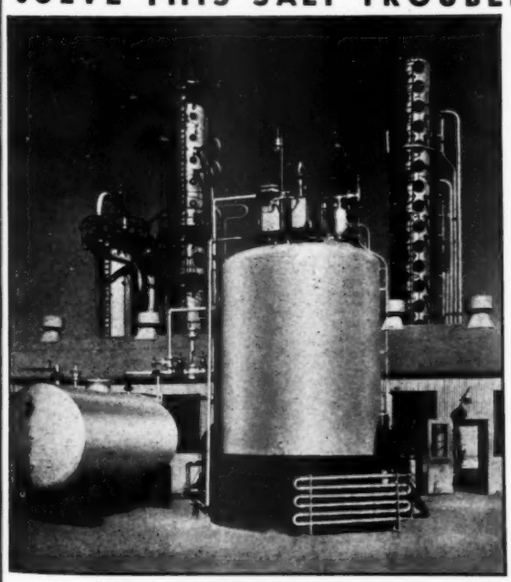
In our department we have small, scattered groups of men and the first approach to the problem is an appeal to the employee to give better regard to his welfare. This means he should watch his diet and habits. The supervisor should give attention to the physical condition of his men by preventing unnecessary exposure in cold, wet weather as well as providing a good drinking water supply for his operating force. On such small details sometimes rests the efficiency of the plant.

A sick man cannot perform his duties. His time is lost and money is lost. Actually unsafe conditions arise from an unwell personnel. Colds are contagious and the whole plant could suffer.



A Petreco Desalter

LOCATED HERE WILL SOLVE THIS SALT TROUBLE



Petreco Desalting reduces the salt content of the charging crude to such an extent that shutdowns, except for periodic inspections, are virtually eliminated. For example, in a Kansas refinery the salt content of the crude was reduced from 70 to 4.5 pounds per thousand barrels. This reduction of salt resulted in a daily throughput increase of 500 barrels.

While on-stream time and increased capacities are always important, our national defense program makes corrosion and metal losses increasingly serious because of the scarcity of the high quality steels and alloys required for replacements. Corrosion and plugging of exchanger tubes; coking, corrosion and metal losses from "rattling" in furnace tubes, are all maintenance expenses caused by salty crudes. In distillation, acids are evolved from the salts in crude oils, resulting in corrosion all through the refinery system.

Petreco desalters are operating in refineries ranging in size from little more than topping plants to large capacity refineries manufacturing all the well known petroleum products. Out of the numerous Petreco installations, every one has justified its installation economically, and many have led to "repeat" installations.

Petreco representatives, with years of experience in combating salt depredations, are always ready to discuss your particular problem. Pilot tests and preliminary estimates entail no obligation.

PETROLEUM RECTIFYING COMPANY OF CALIFORNIA

General Offices: Los Angeles, California

Gulf Coast Division: Houston, Texas — *Eastern Division:* Toledo, Ohio

Representatives In Principal Oil Fields and Refining Centers

PETRECO

DESALTING DEHYDRATING

Test Methods for Control of Gasoline Treating Processes

PETROLEUM ENGINEER Exclusive Feature

☆ **Periodic tests of stocks during treatment to determine degree of sourness, etc., are important if maximum lead response and other properties are to be obtained**

by A. W. Trusty

Chief Chemist, Arkansas Fuel Oil Company

THE refinery treating plant always has been regarded as a necessary evil in the refining of petroleum products. In the past, little attention has been paid to the efficiency or ease of operation of the treating equipment. Treating was considered an "art;" therefore the whole problem was left to the varying skill and technique of the treater.

Today, the refiner is recognizing the importance of the treating plant. The effect of excess sulphur and polysulphides on tetraethyl lead susceptibility and on gum inhibitor requirements is being appreciated as never before. The present higher octane number gasoline with increased amounts of tetraethyl lead, has emphasized the ill effects of improper treating. Also, the development of several commercial treating processes wherein no sulphur is used in treatment, or in others wherein the mercaptans are completely removed, and the improvement that these treating processes show in lead and gum inhibitor susceptibility, has brought to the attention of the refiner the importance of proper treating.

The treater can more intelligently handle his stocks if he knows the degree of sourness, the amount of doctor and sulphur required, and the content of excess sulphur in the treated stock. Several short and easy methods of testing the stocks as they progress through the treating process, have been developed as aids to the treater in his control of the process.

Hydrogen Sulphide in Raw Stock

To determine the presence of hydrogen sulphide in raw stock:

Agitate 2 parts of the sour stock in a 4-oz. bottle with 1 part of cadmium chloride solution (10 percent cadmium solution containing 1 percent HCl). The formation of a yellow precipitate or film indicates the presence of hydrogen sulphide.

A. W. TRUSTY

graduated from Mississippi College in 1925 with a bachelor's degree—Joined staff of Lion Oil Refining Company as chemist and that same year (1925) transferred his affiliation to the Louisiana Oil Refining Company—In 1928 he became chief chemist of that company, which position he retained when later it became the Arkansas Fuel Oil Company—Resides in Shreveport, Louisiana.

The hydrogen sulphide should be removed from the sour stock by a caustic wash before the sweetening operation, regardless of what type of sweetening is to be used.

Mercaptan Content of Sour Stock

Two methods are commonly used to determine the degree of sourness of the raw stock. Probably the simplest method is the "copper number" test.

Solution: Use $CuSO_4.5H_2O$. Dissolve 3.9281 grams of copper sulphate in the smallest quantity of distilled water and add strong 30 Bé sodium hydroxide until all the copper precipitates as a blue gel, then slowly add NH_4OH to the solution point of basic copper hydroxide, keeping chilled in an ice bath. Add 100 cc. excess NH_4OH and make up to one liter with distilled water. If the solution turns brown or, if there is any precipitate in the bottom of the finished solution, dump and repeat the above. The solution must be kept chilled during its preparation. With an excess of NH_4OH present, the solution may be stored in the same manner as NH_4OH.

Determination of copper number: Wash the sour stock with cadmium chloride solution to remove hydrogen sulphide. Measure 100 cc. of the sour stock into a small separatory funnel and add 1 cc. of the copper solution, shake well, settle, and draw off. Repeat, adding 1 cc. of copper solution at a time, shaking and drawing off until the copper solution very definitely retains its blue color in the bottom of the funnel. The total number of cc. of copper solution added in this manner is the copper number of the oil sampled.

The mercaptan content can be determined by referring to Fig. 1.

Alternate Method[1]

Reagents: Silver nitrate 0.05N
Ammonium thiocyanate 0.05N

Iron alum, ferric ammonium sulphate, solution. (Add 40 grams of iron alum to 20 cc. of 6N nitric acid, boil, and dilute with 9 parts of distilled water.)

Procedure: To 100 cc. of the hydrogen sulphide-free gasoline, add an excess of 0.05N silver nitrate and shake for 5 minutes to insure complete reaction. Add 2 cc. of the iron alum solution and titrate with 0.05N ammonium thiocyanate until a deep red color appears.

Calculation:

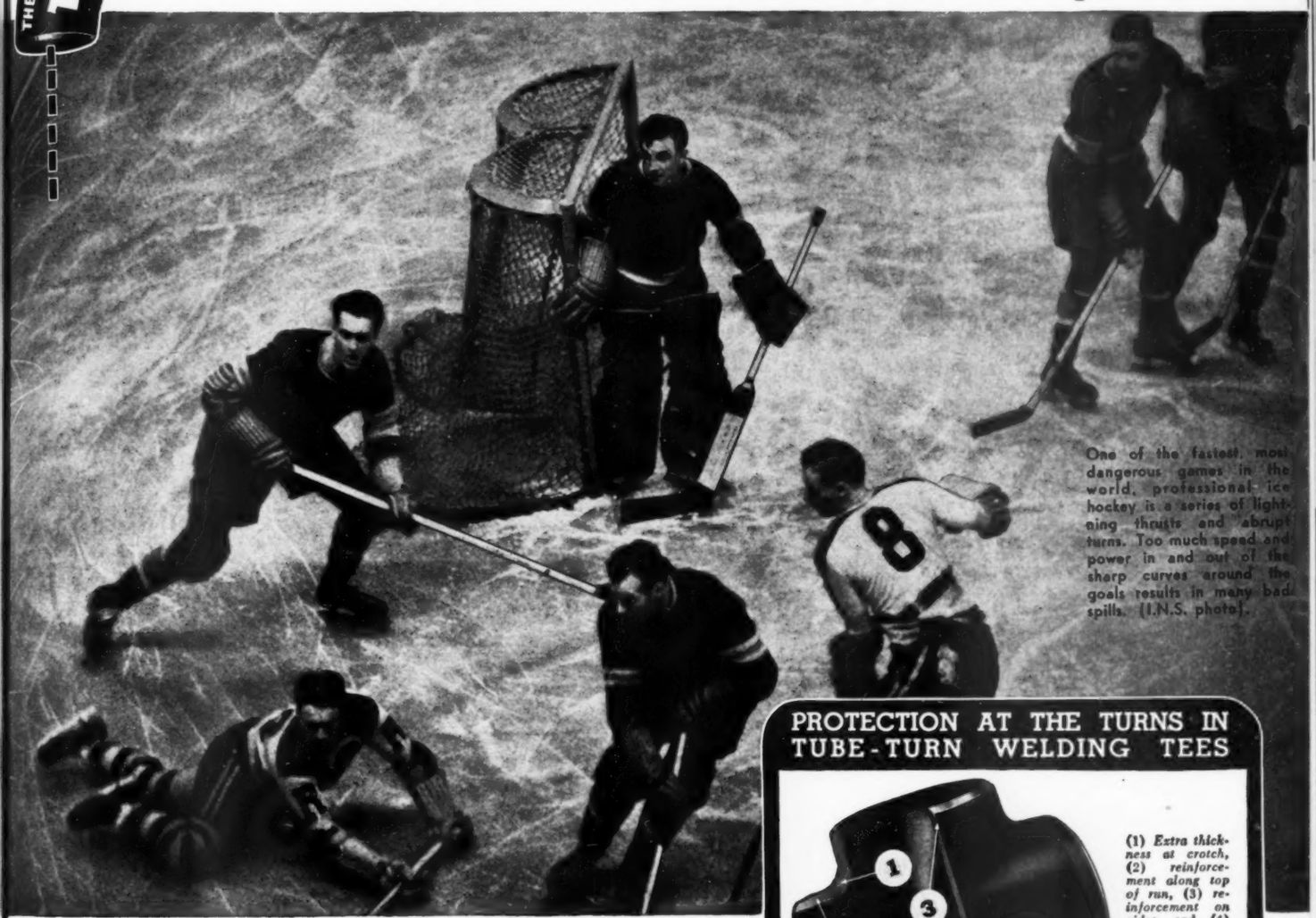
$$\frac{\text{cc. } AgNo_3 \times 0.032 \times 100}{\text{wt. of sample}} = \text{percent of sulphur as mercaptans.}$$

The knowledge of the mercaptan content is valuable in several instances.

[1]P. Borgstrom & Reid, *Ind. Eng. Chem.* Anal. Ed. 1, 186 (1929).

THE DANGER LIES AT THE **TURNS**

---- LOOK OUT when force hits the turns in PIPING, too!



One of the fastest, most dangerous games in the world, professional ice hockey is a series of lightning thrusts and abrupt turns. Too much speed and power in and out of the sharp curves around the goals results in many bad spills. (I.N.S. photo).

Welding with TUBE-TURN Fittings removes "Danger at the Turns" in Piping!

Abrupt turns and surging speed—the very things that cause most accidents in hockey—also account for major piping troubles.

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There are all types, sizes and weights of Tube-Turn welding fittings—elbows, returns, tees, reducers, laterals, nipples, and flanges. For *every* welding fitting need, specify Tube-Turn fittings *by name!*

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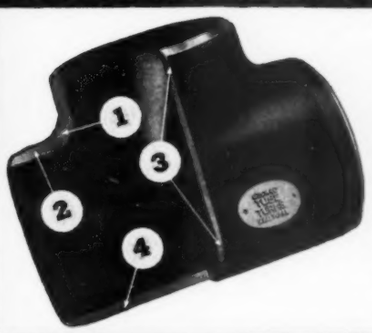
PROTECTION AT THE TURNS IN TUBE-TURN WELDING TEES



(1) *Extra thickness at crotch,* (2) *reinforcement along top of run,* (3) *reinforcement on sides,* and (4) *increased thickness at bottom* give extra strength to Tube-Turn tees at the points where stress and strain are greatest.

CROSS-SECTION OF TUBE-TURN ELBOW SHOWS SUPERIOR DESIGN

OUTER WALL NOT STRETCHED OR THINNED
SMOOTH INTERIOR WALLS NO WAVES OR RIDGES
EASY SWEEPING RADIUS THROUGHOUT
MINIMUM RESISTANCE TO FLOW
INSIDE WALL NOT THICKENED
CLEAN ACCURATE BEVEL

Here are vital engineering advantages that tell quickly why you get more with Tube-Turn welding elbows—*the elbow that made ALL Tube-Turn fittings famous.*

In copper chloride treating, where oxygen is used, the mercaptan content indicates the quantity of oxygen to use for complete sweetening. When a caustic wash is used for mercaptan removal before the sweetening operation, the determination of the mercaptan content before and after the caustic wash gives an indication of the efficiency of the caustic wash. The treater thus knows whether to circulate a larger volume of caustic with the gasoline, or whether the regeneration of the spent caustic in the steam stripper is efficient, or, whether the caustic in use has become contaminated with organic acids to the point that it is no longer effective for mercaptan removal.

In doctor treating, the mercaptan content of the sour stock is an index to the quantity of free sulphur to use to make the "break." The plant chemist can supply the treater with a chart or table showing the amount of sulphur necessary theoretically to break out gasoline with varying mercaptan sulphur contents. The treater can check this theoretical figure against enough of his actual treats to establish another chart that will then tell him how much sulphur to use for any particular stock.

The theoretical sulphur may be determined also, as follows:

Reagents:

1.0N butyl mercaptan solution in 0.5N cleaner's naphtha

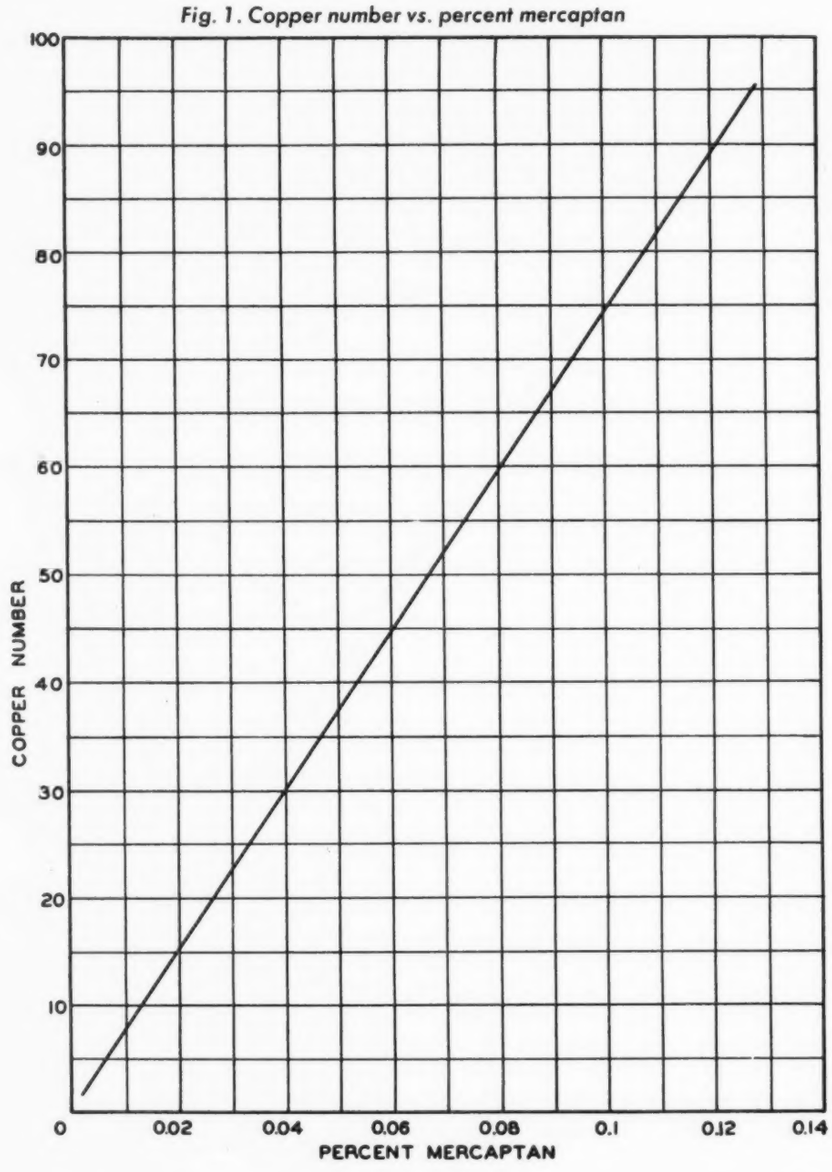
Doctor (sodium plumbate) solution

Silver nitrate 0.05N

Ammonium thiocyanate 0.05N

Ferric alum indicator.

Fig. 1. Copper number vs. percent mercaptan



Procedure: Add 20 cc. of the doctor solution to 150 cc. of the sour gasoline and agitate for 10 minutes. Allow to settle and draw off the doctor solution. Wash the oil with 75 cc. of 20 percent sulphuric acid for 10 minutes and drain the acid layer. Wash with cadmium chloride and drain. Determine the mercaptan sulphur content by the silver nitrate method previously described.

Weight of sulphur per 100 cc. of gasoline = 0.5 weight of mercaptan sulphur.

Litharge in Doctor Solution[2]

Reagents: Ammonium molybdate $(NH_4)_6\ Mo_7O_{24}.4H_2O$. Make up solution so that 1 cc. is equal to 1 gram of lead oxide per liter when a 25 cc. sample of doctor is used:

Lead chloride.

Ammonium acetate, saturated solution.

Acetic acid, 50 percent.

Tannic acid, 0.5 percent.

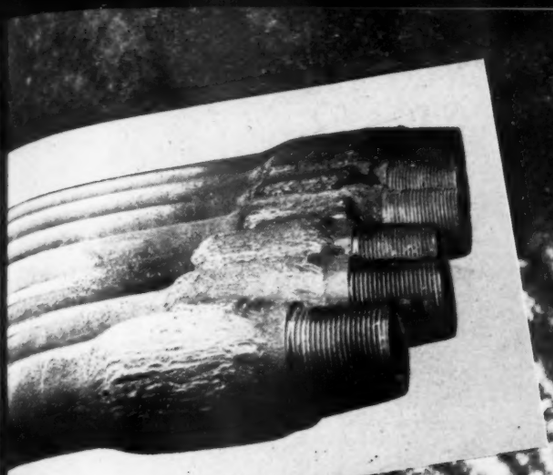
Procedure: Using a pipette, measure 25 cc. of the doctor solution into a 250 cc. beaker. Add 50 to 75 cc. of water and neutralize the caustic soda with 50 percent acetic acid, as evidenced by the redissolving of the precipitate first formed. Avoid a large excess of acetic acid. Heat the solution to boiling and titrate while hot with standard molybdate solution until a drop or two shows a distinct yellow color with a drop of 0.5 percent tannic acid on a porcelain spot plate.

cc. of molybdate solution × 0.00834 = lb. of litharge per gal. of doctor solution.

Excess Sulphur in Doctor-Sweetened Gasoline

It has been found convenient to control the addition of sulphur in practical doctor plant operation by the widely used butyl-mercaptan test. To 30 cc. of gasoline, filtered free from lead sulphide, in a 4-oz. sample bottle, are added 20 cc. of a dilute butyl-mercaptan solution (1 to 1400 by volume in cleaner's naphtha, containing no free sulphur) followed by a 10-cc. doctor solution. The bottle is shaken for 15 seconds. The sample should then be light yellow-green in color and transparent. An orange or brown color denotes free sulphur in such form as to make the gasoline corrosive. On standing, the sample will become opaque and may retain its green-yellow color or turn orange or brown, a solid precipitate finally forming. If the color of the sample and precipitate remains yellow for 30 minutes, the gasoline contains a low enough concentration of active sulphur to give optimum results

[2]Ellis, *Refiner & Natural Gasoline Manufacturer* 15, 335 (1936).



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...ting shortage worries

...STOODY HARD-FACING METHOD KEEPS ...T JOINTS WORKING—*AT A SAVING!*

FROM EVERYWHERE—California—Mid-Continent—Gulf Coast—Louisiana—come outstanding reports of how Stoody Hard-Facing Alloys are prolonging tool joint life and eliminating steel shortage worries for operators.

Protected joints are outlasting unprotected joints two-to-one—and more!

Operators are reclaiming old joints . . . greatly increasing new joint life . . . maintaining full joint efficiency.

The Stoody hard-facing application is simple. Use either Electric Tube Borium or Coated Stoody Self-Hardening—and apply directly over the tool joint or to a recess machined in the joint, as desired. The Stoody representative in your territory will gladly supply detailed information on the Stoody method of hard-facing tool joints in your drilling string. Or write for free copy of the Stoody Engineering Bulletin which gives details.

STOODY CO., 1134 W. Slauson Ave., Whittier, Calif.

STOODY COMPANY

with gum inhibitor. If, however, the sample becomes orange colored within 30 minutes, too much sulphur has been used and the inhibitor susceptibility will be below its maximum value.

Used in this way, the butyl mercaptan test is not primarily a test for elementary sulphur. If sulphur is present even in minute amount in sweet gasoline, it will give an immediate dark color in this test. The slow reaction producing the orange color is probably due to the breakdown of unstable sulphur compounds, thought to be polysulphides. It is believed that this test does not detect all polysulphides, for gasolines that are satisfactory according to this test from an inhibitor standpoint, are sometimes lower in octane number than the corresponding sour samples. A sample of sweetened gasoline that will not turn orange in the butyl mercaptan test usually contains not over 0.003 percent active sulphur.

An alternative means of detecting excess sulphur is to shake the sample in contact with mercury; after several minutes of agitation it should not give more than a slight precipitate in the gasoline.

Analysis of Caustic Soda Containing Sodium Sulphide and Sodium Mercaptides

1. Total alkali: Using a pipette, measure 1.0 cc. of the alkaline solution into 50 to 75 cc. of distilled water and titrate with 0.1 normal hydrochloric acid, using methyl orange as the indicator. Calculate the results as grams of NaOH per liter of solution. (1.0 cc. of 0.1N HCl is equivalent to 0.0040 grams of NaOH).

2. Combined sodium sulphide and mercaptide sulphur:

Method A: Using a pipette, measure 1.0 cc. of the alkaline solution directly into a measured quantity of 0.1 normal solution of potassium iodide-potassium iodate diluted to 50-75 cc. The solution is made acid with 10 cc. of concentrated hydrochloric acid, stirred and after standing one minute the excess iodine is titrated with 0.1N sodium thiosulphate solution using starch indicator. Calculate the result in terms of cc. of 0.1N iodine consumed (percent).

The potassium iodide-iodate solution may be made by dissolving 3.6 grams of potassium iodate and 14 grams of potassium iodide in one liter of boiled distilled water.

The amount of $KI\text{-}KIO_3$ solution to use may be determined by a trial titration. Enough should be used that the solution remains a dark yellow color after acidification. (1.0 cc. of 0.1N iodine is equivalent to 0.0039 grams of sodium sulphide or 0.0032 grams of mercaptide sulphur).

Sodium sulphide: Ten cc. of the alkaline solution is diluted to approximately 100 cc. with distilled water and actively boiled 10-15 minutes, adding more distilled water if necessary. Cool and dilute to 100 cc. in a volumetric flask. Using a pipette, measure 10 cc. of the diluted solution and proceed as above. Calculate the results of this titration in terms of cc. of 0.1N iodine (S) which may be converted to grams of sodium sulphide by multiplying by the factor 0.0039.

Mercaptide sulphur: The mercaptide sulphur content may now be calculated as follows:

cc. 0.1N Iodine (T) minus cc. 0.1N Iodine (S) = cc. 0.1N Mercaptide Sulphur.

cc. 0.1N Mercaptide Sulphur × 0.0032 = grams of Mercaptide Sulphur.

To convert sodium sulphide to sodium hydroxide, multiply by the factor 1.05.

To convert mercaptide sulphur to sodium hydroxide, multiply by the factor 1.25.

The results are conveniently expressed in terms of grams per liter of sodium hydroxide so that they may be subtracted directly from that shown in (1) (total alkali) and thus obtain the amount of available or free sodium hydroxide remaining in the solution.

This method may be illustrated by an example:

1. Total alkali:

1.0 cc. of used alkaline solution required 29.5 cc. 0.1N HCl (using methyl orange indicator).

2. Sodium sulphide and mercaptide sulphur:

A. 1.0 cc. used alkaline solution was added to 20 cc. 0.1N $KI\text{-}KIO_3$ solution.

4.5 cc. 0.1N sodium thiosulphate were required for the back titration of excess iodine after acidification.

20.0 — 4.5 = 15.5 cc. 0.1 iodine consumed.

B. 1.0 cc. of the original solution, after boiling, was added to 10.0 cc. 0.1N $KI\text{-}KIO_3$. For the back titration of the excess iodine 2.9 cc. of 0.1N sodium thiosulphate were required.

10.0 — 2.9 = 7.1 cc. 0.1 iodine consumed.

7.1 × 0.0039 gm. Na_2S per cc. 0.1N = 0.0277 × 1000 = 27.7 grams sodium sulphide per liter.

27.7 × 1.05 = 29.1 gm. NaOH per liter equivalent.

15.5 cc. — 7.1 cc. = 8.4 cc. 0.1N iodine equivalent to the mercaptide sulphur present.

8.4 × 0.0032 × 1000 = 26.9 gm. mercaptan sulphur per liter.

26.9 × 1.25 = 33.6 gm. NaOH per liter equivalent.

118.0—(29.1 + 33.6) = 55.3 gm. free NaOH per liter.

Method B. This method is similar to Method A in some respects, but makes use of a standard iodine solution.

A mixture of a measured quantity of standard iodine solution and standard hydrochloric acid is diluted to 200 cc. with distilled water. The acid should be in slight excess over that required to neutralize all the alkalinity, whereas the iodine added should be such that the solution remains a dark yellow after addition of the solution being analyzed.

One cubic centimeter of the original solution is added to the above acid-iodine mixture and after standing one minute the excess iodine is back titrated with 0.1N sodium thiosulphate solution.

Sodium sulphide. This determination is carried out in the same way as shown above, except that the boiled solution is used. The results are calculated in the same way as in Method A.

Peroxide Determination

Reagents:

Titanous chloride solution 0.01N.

Thiocyanate solution. Dissolve 50 gm. ferrous sulphate, 50 gm. ammonium thiocyanate, and 50 cc. of sulphuric acid in the order named in 5000 cc. of distilled water and add 5000 cc. of commercial acetone. About 10 gm. of pure iron wire are placed in the bottle and the air is displaced with hydrogen. After a few days any ferric salts present as impurities will have been reduced by the iron wire to ferrous salts, and the red color will disappear. The solution is then ready for use. No perceptible oxidation takes place within a quarter of an hour or more on exposure of this solution to the air, so that the presence of air during the test does not affect the results.

Procedure: Ten cc. of the gasoline to be tested is shaken vigorously for 5 min. with 50 cc. of the thiocyanate solution. A red color, due to the formation of ferric thiocyanate, is produced if peroxides are present. The ferric salt formed is titrated immediately with the standard titanous chloride solution. The result is expressed in grams equivalent of active oxygen per 1000 liters of gasoline.

The peroxide content indicates the degree to which the gasoline has oxidized. A high peroxide content indicates that preformed gum formation has begun. The gasoline thus will be less susceptible to gum inhibitor and tetraethyl lead blending.

——☆☆☆——

Preference Rating Order P-100 for Repairs, Maintenance, and Operating Supplies

Subchapter B—*Priorities Division*
PART 958—REPAIRS, MAINTENANCE, AND OPERATING SUPPLIES

958.2. For the purpose of facilitating the acquisition of material for (1) the maintenance and repair of the property and equipment of producers as hereinafter defined, and (2) the continued operation of the property and equipment of such producers, a preference rating is hereby assigned to deliveries of such material upon the terms hereinafter set forth. Such terms shall control until such time as the Office of Production Management certifies specific quantities of such material to which the preference rating herein assigned may be applied, or until the Office of Production Management may specifically limit production by any type of producer or withdraw any type of material from use by such producer, or until the Office of Production Management may issue an order specifically relating to the maintenance, repair and operation of the property and equipment of any type of producer.

(a) **Statement of policy.** It is the purpose of this order to effectuate the policy of the Supply Priorities and Allocations Board in maintaining governmental, charitable, and industrial property located in the United States, its territories and possessions, including the Philippine Islands, upon an adequate operating basis, without expansion or improvement of facilities except where duly authorized or approved. The terms and conditions of this order are to be intercepted in conformity with this expressed policy.

(b) **Definitions.**

(1) "Producer" means:

(i) any governmental unit;

(ii) any individual, partnership, association, corporation, or other form of enterprise engaged in one or more of the following capacities to the extent that it is so engaged or so acts;

(a) manufacturing, processing, or fabricating;

(b) warehousing—maintaining warehouses for storage or distribution of any material;

(c) wholesaling — acting as a distributor of products sold to manufacturers, wholesalers, retailers, or other persons not consumers;

(d) charitable institutions—any charitable or eleemosynary institution that is recognized as such for purposes of the Internal Revenue Laws of the United States;

(e) carriers—urban, suburban, and interurban common or contract carriers of passengers or freight by electric railway, electric coach, motor truck, or bus, including terminals of any of the foregoing; railroads, including terminals; shipping — commercial carriers of freight and passengers by ocean, lake, river, or canal, including terminals;

(f) educational institutions (including vocational training);

(g) printers and publishers;

(h) radio—commercial broadcasting and communication;

(i) telephone and telegraph communication, including wire services;

(j) hospitals, clinics, and sanatoriums;

(k) petroleum and natural gas —discovery, development and depletion of pools of petroleum and associated hydrocarbons and derivatives thereof;

(l) irrigation systems, whether publicly or privately owned; toll bridges and toll canals.

(iii) Any person using tools or equipment to repair or maintain the property of any producer as defined in (b) (1) (i) and (ii).

(2) "Material" means any commodity, equipment, accessories, parts, assemblies, or products of any kind.

(3) Subject to subparagraph (6), "Maintenance" means the upkeep of a producer's property and equipment in sound working condition.

(4) Subject to subparagraph (6), "Repair" means the restoration of a producer's property and equipment to a sound working condition when such property or equipment has been rendered unsafe or unfit for service by wear and tear, damage, destruction of parts, or similar causes.

(5) Subject to subparagraph (6), "Operating Supplies" means any material that is essential to the operation of the producer's business and which is consumed in the course of such business including, but not limited to, lubricants, catalysts, small perishable tools, and ferrous material necessary for the fabrication of containers: *Provided*, it shall not include

(i) any material that is physically incorporated, in whole or in part, into any material that the producer manufactures, distributes, sells, stores, or transports; or

(ii) any material that is to be used as fuel; or

(iii) any non-ferrous material to be used as packaging supplies.

(6) The terms "Maintenance," "Repairs," and "Operating Supplies" *do not* include the following:

(i) the replacement of an item carried on the producer's books as a fixed asset;

(ii) material that would not be carried on the producer's books as Maintenance, Repairs, Operating Supplies, or the equivalent, in the producer's established method of bookkeeping;

(iii) material for the improvement of a producer's property or equipment through the replacement of material in the existing installation, unless such equipment is beyond economic repair;

(iv) material for additions to, or expansions of, such property or equipment.

(7) "Supplier" means any person with whom a purchase order or contract has been placed for delivery of material to a producer or another supplier.

(c) **Assignment of preference rating.** Subject to the terms of this order, Preference Rating A-10 is hereby assigned:

(1) to deliveries, to a producer, of material required by him as operating supplies or for the maintenance or repair of his property or equipment;

(2) to deliveries to any supplier, who has received purchase orders rated under this order from a producer or from another supplier, of material that will be delivered by him or by another supplier to the producer to fill such rated orders, or which will be physically incorporated into material that will be so delivered; or which will be used within the limitations of paragraph (f) (2) hereof, to replace such supplier's inventory material delivered to fill orders rated pursuant to this order or pursuant to Preference Rating Order No. P-22, as heretofore amended.

Provided, that when any General Preference ("E" or "M") Order as-

signs a specific preference rating to deliveries of any particular material to be used by a particular industry or for a specific purpose, such preference rating shall control and the A-10 rating hereby assigned may not be applied; and *provided further*, that the preference rating hereby assigned may not be applied to deliveries of any material to be used for purposes prohibited by any order or regulation issued by the Director of Priorities.

(d) **Persons entitled to apply preference rating.** The preference rating hereby assigned may be applied by:

(1) a producer;

(2) any supplier provided deliveries to a producer or another supplier are to be made by him, which are of the kind specified in paragraph (c) and have been rated pursuant to this order.

(e) **Application of preference rating.**

(1) A producer or supplier, in order to apply the preference rating to deliveries of material to him, must endorse the following statement on the original and all copies of the purchase order or contract for such material manually signed by a responsible official duly designated for such purpose by such producer or supplier:

"Material for Maintenance, Repair, or Operating Supplies—Rating A-10 under Preference Rating Order P-100 with the terms of which I am familiar."

"_____"

Name of producer or supplier.

"_____"

Signature of designated official.

Such endorsement shall constitute a certification to the Office of Production Management that such material is required for the purpose stated and that the application of the rating is authorized by this order. Any such purchase order or contract for such material shall be restricted to material the delivery of which is rated in accordance herewith.

(2) The producers and each supplier placing or receiving any purchase order or contract rated hereunder, shall each retain, for a period of two years, for inspection by representatives of the Office of Production Management, endorsed copies of all purchase orders or contracts, whether accepted or rejected, segregated from all other purchase orders or contracts or filed in such manner that they can be readily segregated for such inspection.

(f) **Restrictions on use of rating.**

(1) *Restrictions on producer and supplier.* No producer or supplier may apply the rating hereby assigned to obtain scarce material, the use of which could be eliminated without serious loss of efficiency by substitution of less scarce material or by change of design.

(2) *Restrictions on supplier.*

(i) No supplier may apply the rating to obtain material in greater quantities or on earlier dates than required to enable him to make on schedule a delivery rated hereunder or, within the limitations of (ii) and (iii) below, to replace in his inventory material so delivered. He shall not be deemed to require such material if he can make his rated delivery and still retain a practicable working minimum inventory thereof; and if, in making such delivery, he reduces his inventory below such minimum, he may apply the rating only to the extent necessary to restore his inventory to such minimum.

(ii) A supplier who supplies material that he has in whole or in part manufactured, processed, assembled, or otherwise physically changed may not apply the rating to restore his inventory to a practicable working minimum unless he applies the rating before completing the rated delivery which reduces his inventory below such minimum.

(iii) A supplier who supplies material that he has not in whole or in part manufactured, processed, assembled, or otherwise physically changed may defer application of the rating hereunder to purchase orders or contracts for such material to be placed by him until he can place a purchase order or contract for the minimum quantity procurable on his customary terms; *provided*, that he shall not defer the application of any rating for more than three months after he becomes entitled to apply it.

(g) **Restrictions on withdrawals and inventory.**

(1) Except as provided in paragraph (g) (3) and (4), no producer who has applied the ratings assigned hereby shall, at any time, accept deliveries (whether or not rated pursuant to this order) of any material to be used as operating supplies or for maintenance or repair until the producer's inventory and stores of material to be used for these purposes have been reduced to a practicable working minimum. Such practicable minimum shall in no event exceed 110 percent of the maximum dollar volume of material to be used as operating supplies and for repairs and maintenance in inventory and stores during the corresponding calendar quarter of 1940.

(2) Except as provided in paragraph (g) (3) and (4), no producer who has applied the ratings assigned hereby shall, during any calendar quarterly period, make withdrawals from stores or inventory of any material to be used as operating supplies or for maintenance or repair the aggregate dollar volume of which shall exceed 110 percent of the aggregate dollar volume of the withdrawals of such material during the corresponding quarter of 1940, or, at the producer's option, 27½ percent of the aggregate dollar volume of the withdrawals of such material during the calendar year 1940.

(3) From time to time the Director of Priorities may determine that certain producers or classes of producers are exempt, in whole or in part, from the restrictions contained in paragraph (g) (1), and (2).

(4) Restrictions contained in paragraph (g) (1) and (2) shall not apply to any producer during any calendar quarterly period in which

(i) the total volume of his purchases of material for maintenance, repairs and operating supplies does not exceed $5,000; and

(ii) the total volume of his withdrawals of material for such purposes does not exceed $5,000.

(h) **Audits and reports.**

(1) Each producer or supplier who applies the preference rating hereby assigned, and each person who accepts a purchase order or contract for material to which the preference rating is applied, shall submit from time to time to an audit and inspection by duly authorized representatives of the Office of Production Management.

(2) Each such producer or supplier shall execute and file with the Office of Production Management such reports and questionnaires as said office shall from time to time request. No such reports shall be filed until such time as the proper forms are prescribed by the Office of Production Management.

(i) **Utilities and mines excepted.** This order is not applicable to any utility defined as a producer in Preference Rating Order No. P-46 (Sec. 978.1) as amended from time to time, nor to any operator as defined in Preference Rating Order No. P-56 (Sec. 982.1). The Director of Priorities may from time to time specifically except further

(*Continued on Page 70*)

...they are easily replaced.

MISSION PISTON RUBBERS

THESE TOUGH, replaceable piston rubbers account for the exceptional performance of Mission Pistons in two ways:

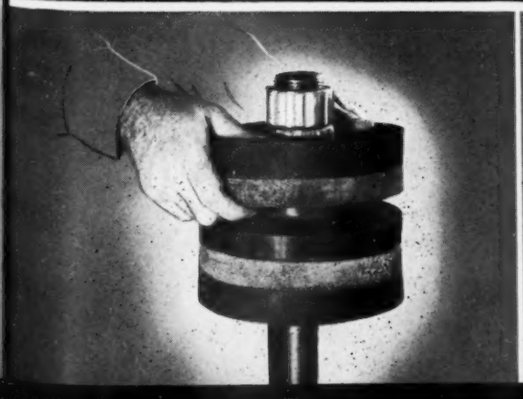
1. **They last longer** — because of a special rubber compound and an advanced design developed by long research and proved through field tests.
2. **They are easily replaced** when they finally wear out... and the cost is much less than a complete new piston.

Proof of the outstanding performance of Mission Pistons is the fact that they are guaranteed to be more economical than the pistons you have been using.

Try these pistons in your pumps—and profit from the long life and low cost that make them the choice of leading oil men in every oil country.

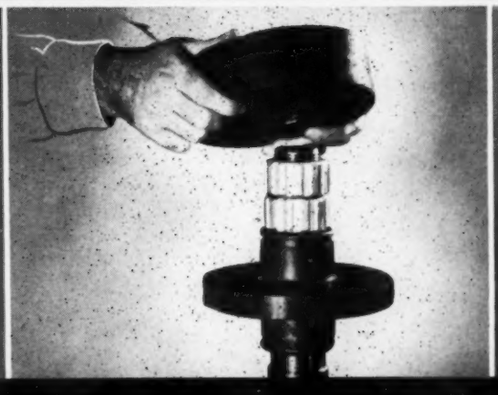
1

When rubbers are worn, you don't have to throw away the entire piston. Simply remove the old rubbers and save the body.



2

It's not even necessary to remove the piston body from the rod. You save on shut-down time when rubbers are changed.



3

NOW new Mission Rubbers are installed and the piston is ready for another long run at much less than the cost of a new piston.

(*Continued from Page 66*)

classes of producers from this order by specific direction.

(j) **False statements and penalties.** Any person who applies the preference rating hereby assigned in wilful violation of the terms and provisions of this order, or wilfully falsifies any records that he is required to keep by this order, or who obtains a delivery of material by means of a material and wilful misstatement will be forbidden to further apply said rating. Such person may also be prohibited from obtaining further deliveries of material under allocation and be deprived of any other priorities assistance. The Director of Priorities may also take any other action deemed appropriate, including the making of a recommendation for prosecution under Sec. 35-A of the Criminal Code (18 U. S. C. 80).

(k) **Revocation or modification.** This order may be revoked or amended by the Director of Priorities at any time as to any producer or supplier. In the event of revocation, or upon expiration of this order, deliveries already rated pursuant to this order shall be completed in accordance with said rating, but no applications of this rating to any other deliveries shall thereafter be made by the producer or supplier affected by said revocation or expiration.

(l) **Effective date.** This order shall take effect immediately. (P. D. Reg. 1, Aug. 27, 1941, 6 F. R. 4489; OPM Reg. 3 Amended, Sept. 2, 1941, 6 F. R. 4865; E. O. 8629, Jan. 7, 1941, 6 F. R. 191; E. O. 8875, Aug. 28, 1941, 6 F. R. 4483; Sec. 2(a), Public No. 671, 76th Congress, Third Session, as amended by Public No. 89, 77th Congress, First Session; Sec. 9, Public No. 783, 76th Congress, Third Session.)

Issued this 18th day of December, 1941.

(Signed) D. M. NELSON,
Director of Priorities.

Model Contract for Aviation Gasoline Plant Expansion

The program of the Office of Petroleum Coördinator for National Defense, aimed at expansion of America's capacity for producing 100-octane aviation gasoline, moved forward December 20 with agreement on a model contract for new plant construction.

A release from OPC states:

"The contract was worked out by representatives of the Cities Service Company, the Defense Supplies Corporation, and the Petroleum Coördinator.

"It not only calls for an immediate start on a $2,000,000 plant in the Middle West, but pilots the way for the completion of similar aviation gasoline contracts with several other refiners who will join the expansion program.

"Under the provisions of the contract a loan will be advanced by the Government for part of the construction costs. The entire output will be purchased by the Government for at least three years. Also contributing importantly to the expansion program was a recommendation by the Internal Revenue Commissioner, permitting liberal depreciation for income tax during the life of the contract.

"The importance of the agreement, worked out in consultation with the coördinator, lies in the fact that it makes it possible for refiners to undertake the large investments with some assurance of a market for a sufficient period of a product now chiefly used in war. Perfection of contracts to enable American refiners to swing into production of the aviation fuel has been pushed by the OPC. Consummation of the Cities Service contract opens the way to immediate execution of additional contracts by other concerns who are in a position to enter the business."

OPA Advances Carbon Black Prices

Because of cost increases that have gone beyond the point where they could be absorbed by a relatively depressed industry and because of reduced revenue from export sales, producers of carbon black were permitted to raise prices by slightly less than 5 percent above present levels on deliveries made beginning January 1, 1942, Leon Henderson, Administrator, Office of Price Administration, stated.

Restriction on Alloys

With the outbreak of war, it has become imperative, the Priorities Division said December 20, 1941, to conserve scarce alloying elements used in the production of alloy iron and steel.

To effectuate this, an amendment to General Preference Order M-21-a has been issued, effective immediately, prohibiting producers from melting any alloy iron or alloy steel containing specified alloying elements in specified amounts, except to fill orders with rating of A-10 or higher, or by special direction of the Director of Priorities.

Effective January 1, was a prohibition of delivery of such materials save on the same terms, with an added proviso that the Director of Priorities may issue orders directing or forbidding specific deliveries.

Manila Cordage for Drilling Cables

Drastic restrictions on the sale of Manila cordage were ordered December 19, 1941, by the Office of Production Management in a further amendment to General Preference Order M-36 covering Manila fiber and cordage, which is imported from the Philippines.

Further manufacture of Class C cordage is prohibited. Such cordage consists half and half of sisal rope and Manila cordage. Stocks now on hand or in process of manufacture may be sold.

Under the latest amendment, Manila cordage may be sold by processors and dealers only for the following categories of orders:

1. Defense orders accompanied by preference rating certificates (not including a Preference Rating Order) having a rating of A-1-j or better.

2. Commercial marine usages in vessels engaged in the carriage of cargo or passengers, or in towage, lighterage, or fishing for commercial fish markets or canneries, and usages for shipbuilding. (Boats used in taking out sportsmen for hire are excluded.)

3. Oil wells and gas wells—for drilling cables only.

Sales of existing stocks have been further restricted. Previously such sale was permitted in lengths of 540 ft. or less. Now it is limited to 200 ft. or less, provided the rope has already been cut in such lengths.

With certain exceptions, Manila fiber may be imported only by the Defense Supplies Corporation or the Navy. The exceptions are certain existing contracts with cordage manufacturers where shipping is scheduled between now and April 30, 1942.

Toluene Allocated

All toluene in the United States will be subject to allocation beginning February 1, 1942, in accordance with the terms of an amendment to General Preference Order M-34 issued December 30 by the Director of Priorities. The order will apply to stocks on hand as well as to toluene produced after that date.

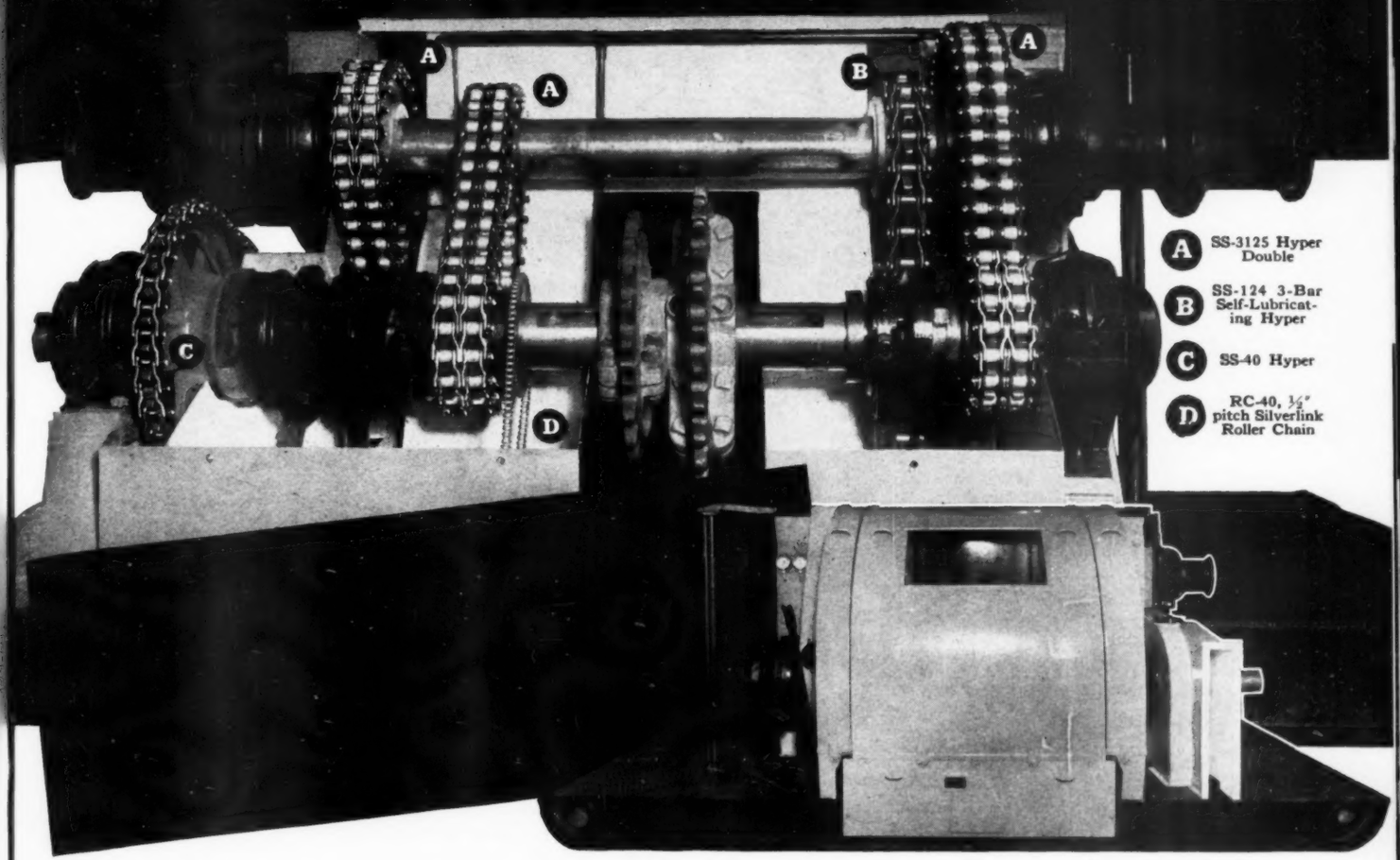
On or before January 15, 1942, and each succeeding month, every producer of toluene is required to file with the Chemicals Branch of the Office of Production Management his estimated production and scheduled deliveries of commercial grade toluene for the following month. No deliveries may be made after February 1 without authorization from the Director of Priorities, except that deliveries may be made according to the schedule as filed if no word to the contrary is received from the Director of Priorities before the 25th of the month before which the scheduled deliveries are to be made.

Beginning February 1, 1942, at least 70 percent of the total production of all producers of toluene must be of nitration grade, meeting the requirements of Grade A in United States Army specifications.

——☆☆☆——

This Modern Oil Bath Drawworks

uses 4 TYPES OF LINK-BELT CHAIN



• Three of Link-Belt's numerous types of "SS" Class Rotary Chains are employed on the drives of the modern oil bath drawworks pictured here. Each of these heavy-duty rotary chains has been selected for a specific service . . for the job both rig manufacturer and rig user know it will successfully perform.

Driving the oil pump is a ½-inch pitch Silverlink roller chain, another Link-Belt type which in recent years is filling an important place on heavy-duty drawworks, portable drilling rigs, cleanout service units, winches, pipe line equipment and general utility service in the oil fields.

From the original Ewart Detachable Link-Belt Chain, introduced 67 years ago, has grown the Oil Industry's most complete line of chains. Link-Belt today manufactures a type and strength of chain for every drilling service, regardless of depth or load . . 50,000 to 230,000 pounds ultimate strength . . 3,000 to 15,000-foot drilling.

Together, Link-Belt rotary and roller chains are "filling the bill" for chain drives in the oil country. They are providing a specific chain for every conceivable service.

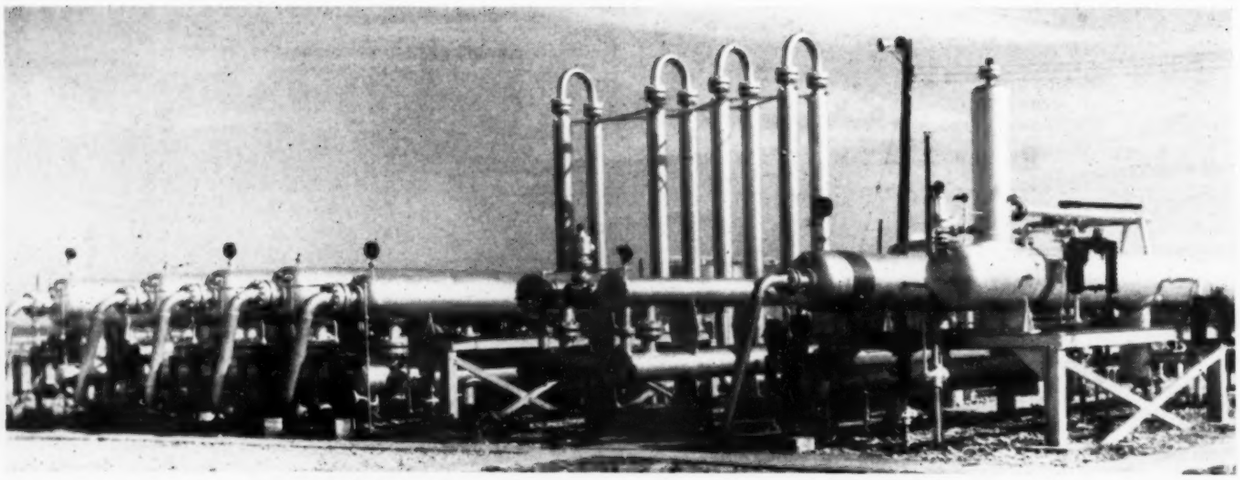
Yes, for more than two-thirds of a century Link-Belt has continuously enlarged its line of chains . . continuously improved the quality, to keep ahead of industry's requirements. And this progressive policy shall continue . . for Link-Belt will never stop improving chain.

LINK-BELT COMPANY 8748

Leading Manufacturer of Mechanical Power Transmission Equipment

Indianapolis Houston Dallas Los Angeles New York Toronto Distributors in all fields

LINK-BELT CHAINS



Absorption and separation equipment as installed in Francitas plant

Francitas Cycling Plant Extracts Condensate at High Pressure

PETROLEUM ENGINEER Exclusive Feature

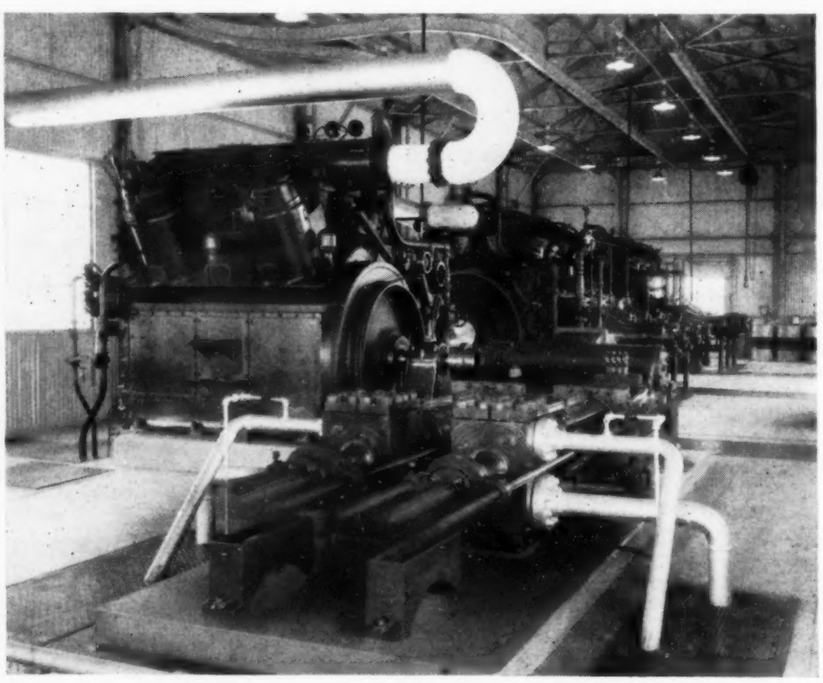
☆ **Liquid products recovered from gas phase by multiple-stage "concurrent" absorption method—Wellhead pressure of 2800 lb. per sq. in. reduced at plant to 2000 lb.; gas returned to sand at 2920-lb. pressure**

by Frank H. Love
Managing Editor

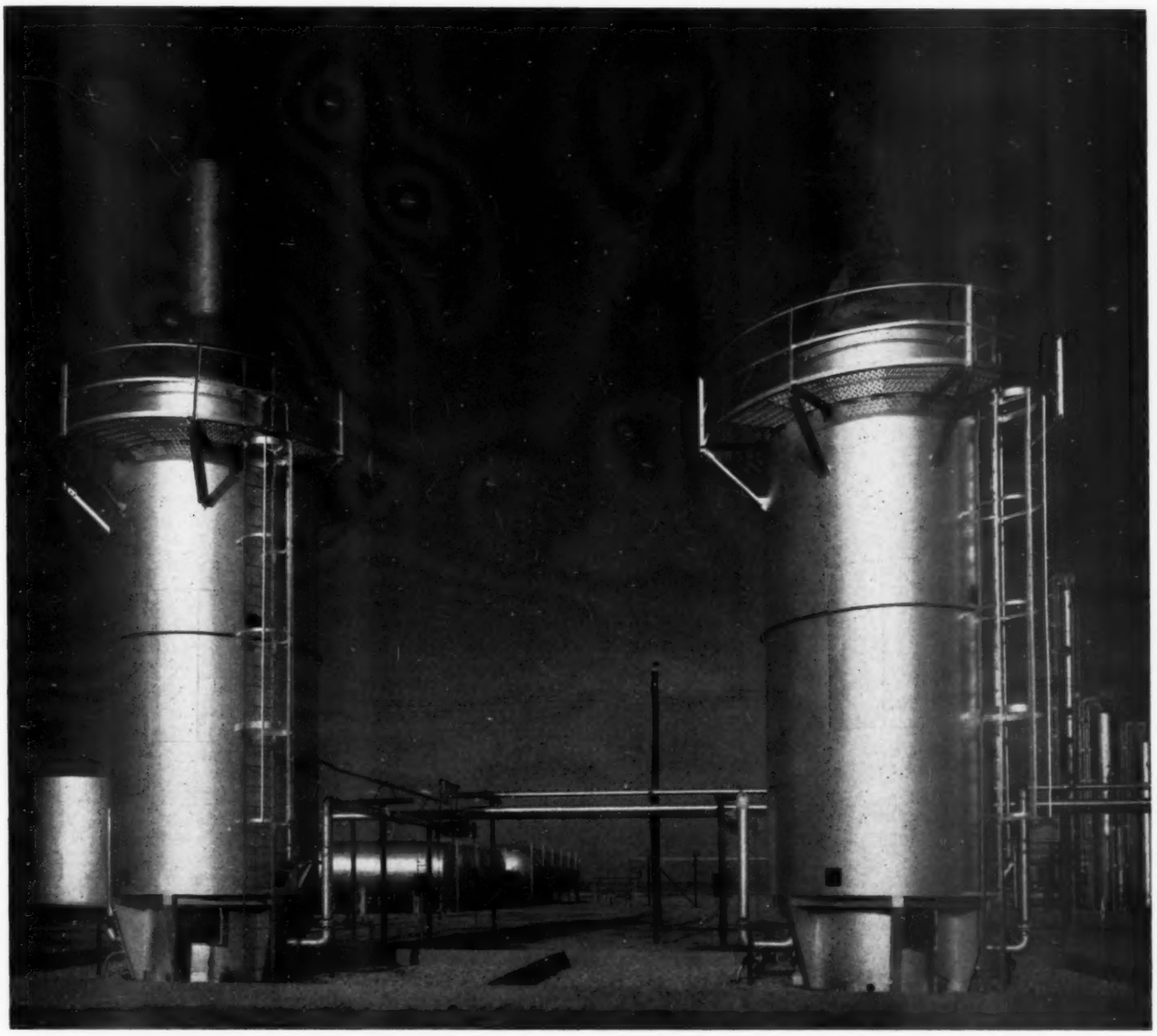
THE most recent cycling plant to be placed in operation in the South Texas area is that of the Francitas Gas Company in the Francitas field, Jackson County. Liquid products are recovered from the gas phase by multiple-stage contact "concurrent" absorption, utilizing horizontal separators in the process. This method makes possible extraction of condensate from the last separator at a high pressure, reducing the compressor horsepower required to return the residue gas to the high-pressure producing formation.

Having a capacity of 60,000,000 cu. ft., the plant is supplied by five producing wells and another is being drilled. The wells are producing from the Weed sand at an approximate depth of 7400 ft. Each producing well is equipped with a choke valve to regulate the volume of flow. Production is metered both at the well and upon arrival at the plant.

The wellhead pressure of 2800 lb. per sq. in. is reduced to about 2000 lb. at the plant by a pressure-reducing valve, after which the gas flows



Gas is compressed from 1900 to 3000 lb. by two 600-hp. V-type compressors. In foreground is the high-pressure lean oil pump and 400-hp. gas engine that drives it



ISO-FLOW FURNACES FOR RECYCLING PLANTS

The above photograph shows two identical PREFABRICATED *furnaces, each shipped as complete units for rapid field assembly.*

Iso-Flow Furnaces are now being used in all phases of the petroleum industry.

PETRO-CHEM DEVELOPMENT CO.

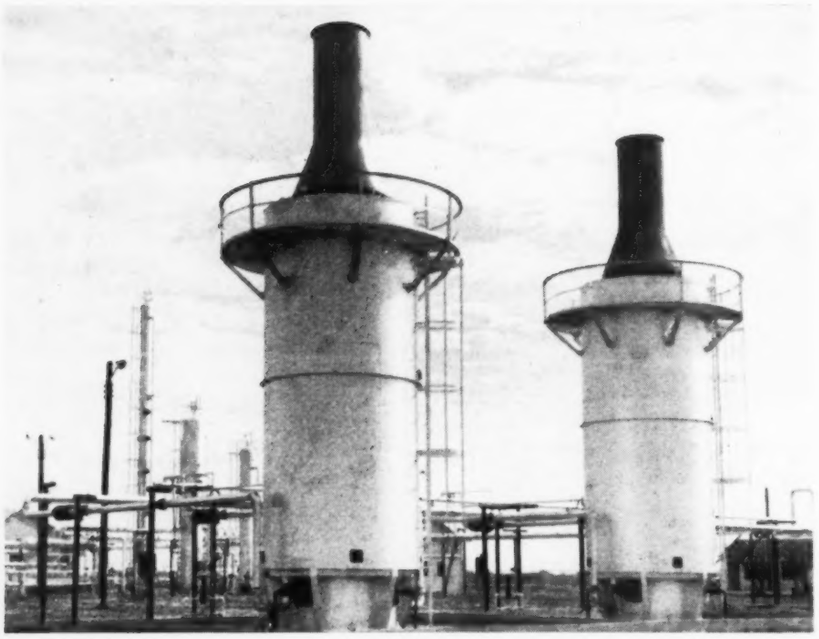
INCORPORATED

120 EAST 41st STREET, NEW YORK, N. Y.

Representatives

FAVILLE-LEVALLEY CORPORATION
MARQUETTE BLDG., CHICAGO

BETHLEHEM SUPPLY COMPANY
TULSA, OKLAHOMA



In the stills (furnaces) rich oil is heated from 325° to a temperature of 510° F.

through two sets of coolers that reduce the temperature of the gas from 108°F. to 85°F. These coolers are horizontal units 10 in. in diameter by 20 ft. long in which water is the cooling medium.

From the coolers the gas enters a water knockout 24 in. O.D. by 20 ft. long, in which the condensed hydrocarbons and condensed free water are separated from the flow stream. The water and condensate are trapped to a water and gasoline separator, whence the water is discharged to the flare pit. The gas flows in stages through a series of four absorbers and four separators, the absorption oil being introduced initially into the final absorber, after which it passes through the other three absorbers in countercurrent flow. The absorbers are vertical, 14 in. O.D. and 15 ft. high, whereas the separators are horizontal and 30 in. O.D. by 20 ft. long. Absorbers and separators both are designed for a working pressure of 2200 lb. per sq. in.

Upon leaving the final separator the dry gas enters the intake of two 600-hp. V-type compressors at a pressure of about 1900 lb. per sq. in. and a temperature of 90°F. After single-stage compression, the gas is discharged to the input wells at a pressure of 3000 lb. and a temperature of 165°F.

It should be mentioned that all condensate and rich oil is discharged from the high-pressure system into an intermediate pressure flash tank system operated at 1000-lb. pressure. Gas evolved in this operation is recompressed—for return to the sand—to 3000-lb. pressure in a special cylinder on the engine that drives the power reflux pump, a volume of 2½ million cu. ft. per day being returned.

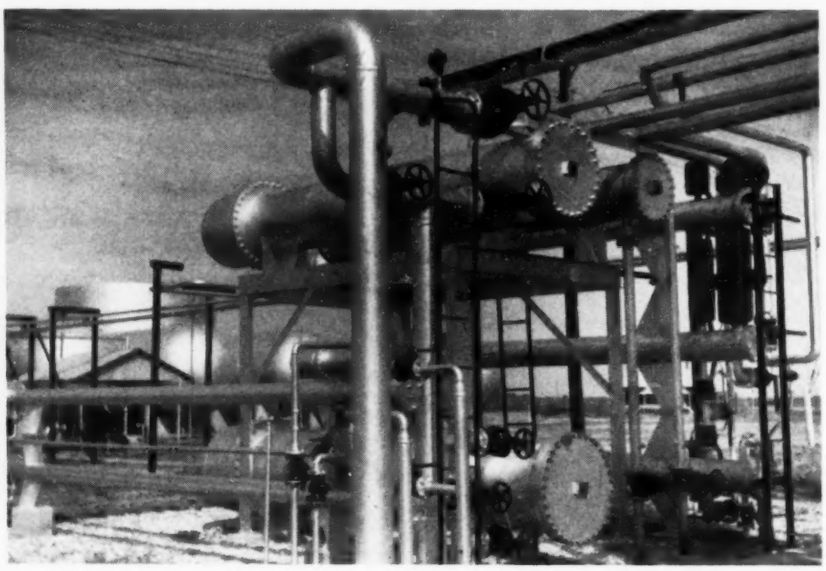
The high-pressure line to the two input wells is 4-in. diameter and the gas is injected into the well casing at a pressure of 2920 lb. per sq. in. Injection gas is metered at the plant and again at the well. Both input wells are equipped with check valves to prevent backflow of gas.

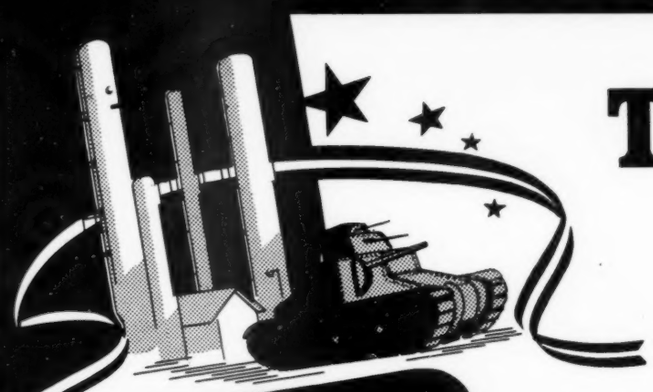
Processing

The rich oil, upon leaving the final separator, is trapped to a 300-lb. flash tank, after which it flows through heat exchangers in which absorption oil flowing countercurrently is the heating medium, then to the stills, or as they are popularly termed in this plant, "furnaces." There are two of these furnaces (shown in one of the accompanying illustrations). The design is such that, when desirable, the rich oil stream can be split and either or both of the furnaces used. Rich oil enters the furnace or still at a temperature of 325°F. and is heated to a temperature of 510°F., going then to a fractionator 4-ft. 6-in. diameter by 35-ft. 8-in. long, which is operated at a pressure of 56 lb. per sq. in. In this tower the gasoline is separated from the absorption oil, the latter passing through heat exchangers and finally through oil coolers before entering the lean oil tank at a temperature of 95°F. ready for another cycle.

On the fractionator a bottom temperature of 485°F. and a top temperature of 380°F. are maintained. Rich oil enters the fractionator at a temperature of approximately 480°F. and vapors leave at the top at a temperature of approximately 380°F. These vapors are discharged through two condensers in series, the temperature being reduced to 140°F. in the first and to 85°F. in the second, the condensate passing to a horizontal gasoline accumulator 5-ft. diameter by 20-ft. long, operated at 56-lb. pressure. Vapors from the gasoline accumulator, as well as those from the 300-lb. flash tank, are led to a reabsorber 3 ft. by 26 ft. 11 in., the rich oil from this reabsorber being pumped to the 300-lb. flash tank to join the main stream. A 10 by 7 by 16 steam-driven pump picks up the gasoline from the accumulator and pumps it to a stabilizer 2-ft. 6-in. diameter by 65-ft. 8-in. long, which is

A group of coolers, condensers, and sub-coolers

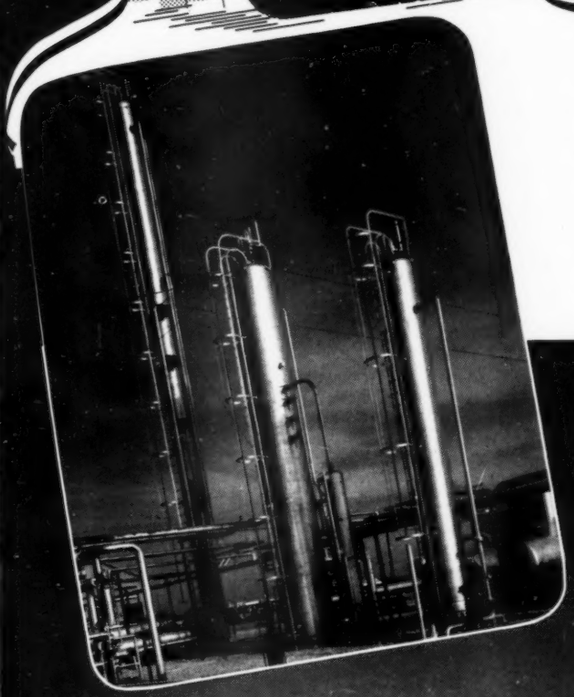


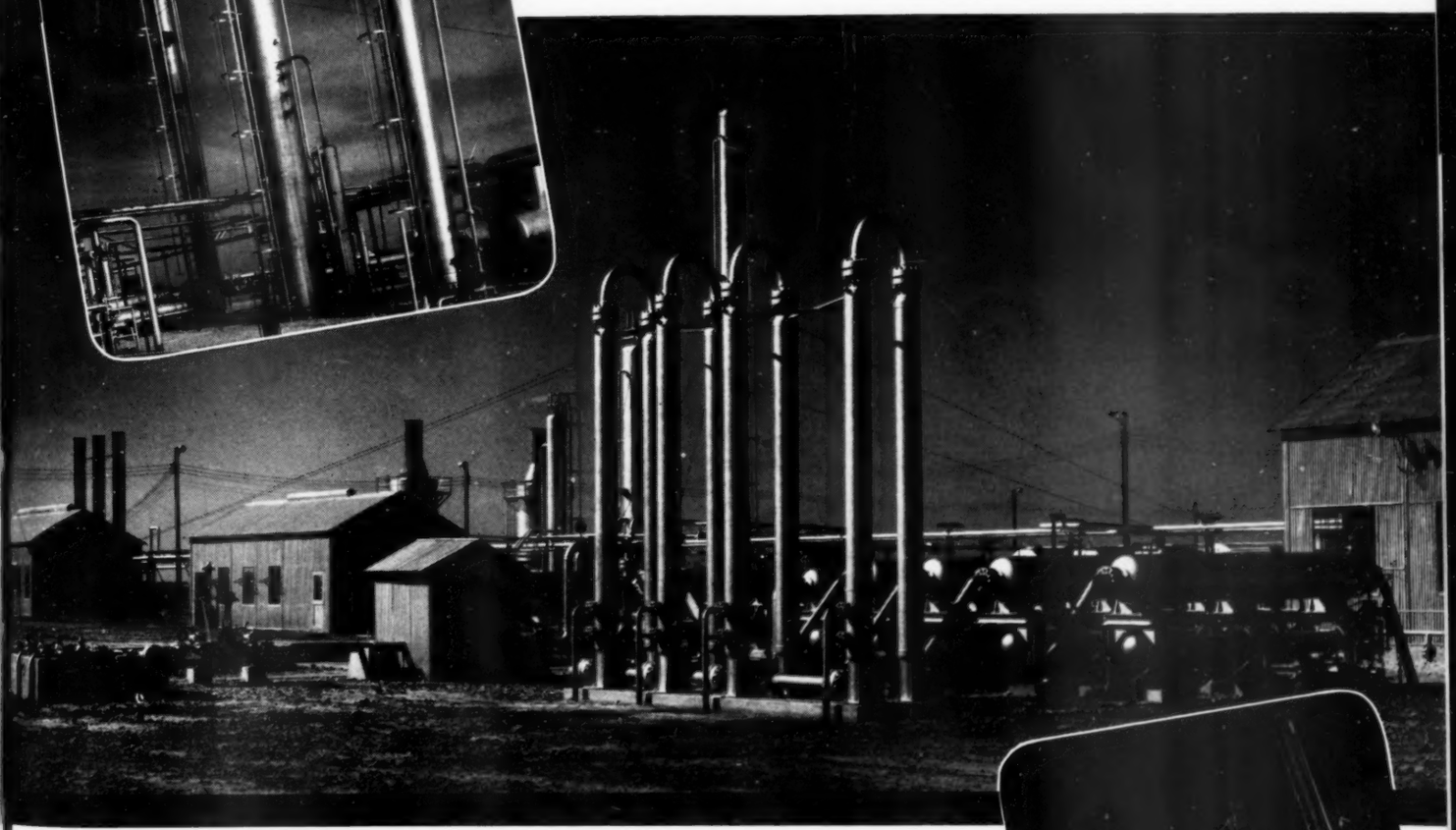


THE TANKS *Behind* THE TANKS

Perhaps nothing is more vital to National Defense and aggressive war effort than petroleum and its products. The consequence of an inadequate supply would certainly be disaster. It is not enough to merely produce these products but they must be produced in ever increasing quantities. To do this, waste and inefficiency must be curtailed. Available petroleum must be recovered with a minimum of waste and expense.

It is with this in mind that we pledge ourselves to an ever increasing effort toward the development of better equipment essential to the Petroleum Industry, designed to eliminate waste and increase recovery.





CYCLING PLANT, FRANCITAS GAS COMPANY
PALACIOS, TEXAS

Preserving the liquefiable products of an 8000-foot to 9000-foot deep vapor phase gas reservoir. Operating at 1800 pounds per square inch with maximum recovery and returning the gas to the original subsurface reservoir.

Plant extraction units, tanks, towers, stabilizers, accumulators, etc., all furnished by National. Plant licensed under Depco patents.

It's a National

NATIONAL TANK COMPANY
TULSA, OKLAHOMA.

operated at 140-lb. pressure and 150°F. From the stabilizer the gasoline goes through a reboiler, its temperature being increased to 309°F., flows through the same heat exchanger through which it passed before entering the stabilizer, and finally to a cooler, where the temperature is reduced to 84°F. before the product is discharged to stock tanks. Vapors from the stabilizer are discharged through a condenser into the reflux accumulator, the product being used to control overhead temperature on the stabilizer. Incidentally, overhead temperature on the stabilizer is maintained by pumping a controlled volume of reflux, whereas the overhead temperature on the fractionator is maintained by pumping a volume of reflux established by the top-temperature condition.

The product from the stabilizer is a 410-endpoint motor fuel, which passes to six 40,000-gal. horizontal hemispherical-head tanks, and four 20,000-gal. horizontal bumped-end tanks. In these tanks the gasoline is mixed with excess absorption oil taken off the fractionator to form a 14-lb. condensate. This product is transferred by a steam-driven pump to two 5000-bbl. vertical tanks, from which the purchaser, The Texas Pipe Line Company, pumps the product directly into its line.

To Executives Interested in Recycling Plants

H. B. Zachry Company is prepared to assume undivided responsibility in the construction of your plant, including investigation, design, turn-key construction and financing.

Design: The firm of Foran, Boatright and Dixon, consulting engineers, has been retained to design plants built by H. B. Zachry Company.

Financing: The H. B. Zachry Company is prepared to assist in financing your plant if desired.

Skill, Integrity and Responsibility: Adequate financial backing, long experience and millions of dollars per year in successfully completed contracts is your assurance that all conditions will be satisfied. This company built the Francitas Gas Company plant in Jackson County and the Gasoline Production Corporation plant at Grapeland.

Your request for further information will be promptly answered. We shall be pleased to talk over your problems and furnish suggested designs and cost estimates.

Gasoline Plants — Recycling Plants — Pressure Maintenance Plants — Pipe Lines

H. B. ZACHRY COMPANY

General Contractors

SAN ANTONIO, TEXAS
Harding Boulevard

LAREDO, TEXAS
2019 Lincoln Street

HOUSTON, TEXAS
909 Second National Bank Building

Lean oil is delivered to the high-pressure system by a 3½ by 16 duplex, reciprocating plunger pump connected by a stub shaft and outboard bearing to a 400-hp. gas engine, which is also equipped with a single 4¼-in. forged-steel compressor cylinder. A steam-driven 26 by 6½ by 20 simplex plunger pump provides standby for this service.

Although only a stabilized crude distillate is being manufactured at the present time, a side stripper off the fractionator has been installed to facilitate the production of endpoint gasoline, kerosine, and fuel oil when desirable.

Compressors

The two 600-hp., V-angle compressors, for compressing the gas and discharging it to the injection wells, are sized to work at 3000-lb. discharge and the maximum safe working pressure of the forged steel cylinders is 6000 lb. per sq. in. Each unit has six 14 by 14 power cylinders and three 4¾-in. by 14 single-acting, piston-suction-type, forged-steel compressor cylinders.

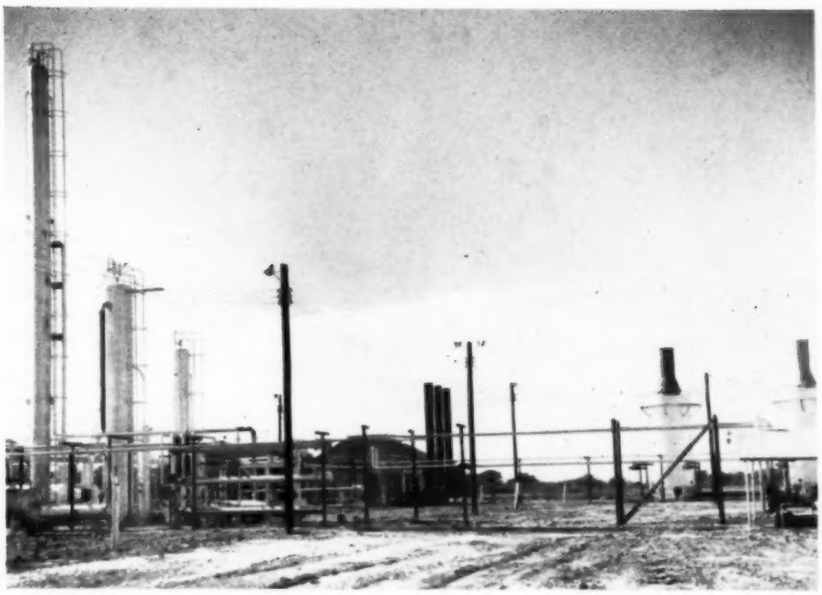
To recondition the lubricating oil a small part of the engine oil pump stream is diverted through a pressure-type oil filter, then returned to the oil sump in the base of the engine.

Engine jackets are cooled by water in a closed system. From a 500-gal. supply tank the water gravitates to the built-in centrifugal pump, each engine having one such pump that is belt-driven by the engine flywheel. The pumps discharge through the lube-oil cooler into the engine cooling system, the water then returning to the supply tank. At normal speeds each pump can circulate 25 gal. of water per b.hp-hr.

Compressed air of 250-lb. pressure required to start the engines is provided by a small air compressor and three horizontal air tanks of 16 in. diameter by 18 ft. long. The compressed air is admitted to the power cylinders through cam-operated timing valves.

Steam Plant

Steam required in processing and to drive the plant's turbines and steam pumps is provided by three 125-hp. boilers having a working pressure of 200 lb. per sq. in. The boiler feedwater tank has a capacity of 50 bbl. All plant exhaust steam is returned to the boiler feedwater tank through a condenser, thus only a small quantity of make-up water is required. An automatic level controller on the boiler feedwater tank cuts into a water well line to provide what make-up water is needed. There



General view through processing area of plant

are two 7 by 4½ by 10 feedwater pumps, one of which serves as a stand-by.

Water Wells

Water is supplied from three wells drilled on the plant site to a depth of approximately 300 ft. The water is lifted to the surface by a deepwell pump driven by a gas engine, and discharged into a header, from where it is pumped through the plant water system, thence into a nearby river in lieu of a hotwell.

Electric Power

The principal source of electric power is provided by a steam turbine driving a 31.3-kva., 3-phase, 1800-r.p.m., 208-120-volt, 87-amp., 60-cycle generator equipped with a 6-kw., 115-volt, 5.2-amp., 1700-r.p.m. exciter. A switch connection also has been made for the use of REA electric power as stand-by when needed.

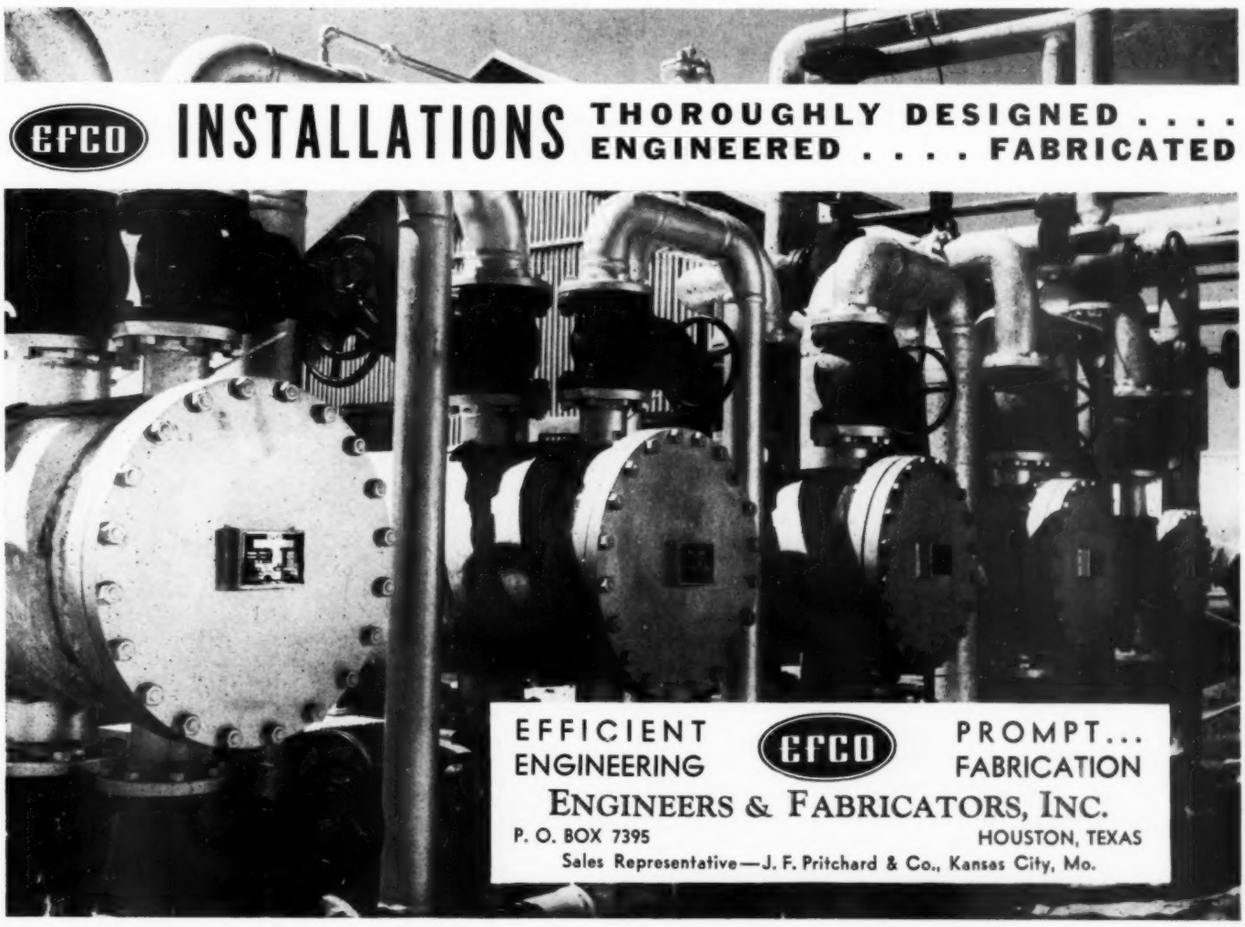
Buildings and Cottages

Office, laboratory, and warehouse are housed in a single building of frame and asbestos shingle construction. Other plant buildings are of steel truss construction covered with galvanized corrugated iron. The compressor building is 122 ft. long by 30 ft. wide, the pump house, 38 ft. long by 18 ft. wide, and the boiler house, 50 ft. long by 24 ft. wide.

Eleven 5-room cottages provide living quarters for the plant's operating personnel.

Contractors

H. B. Zachry Company of Houston, San Antonio, and Laredo, Texas, was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the general contractor in charge of construction. The plant was designed by Foran, Boatright, and Dixon of Houston. The high-pressure processing method and method of gas injection are licensed by Distillate Engineering and Processes Company of Tulsa, Oklahoma.

Principal Equipment

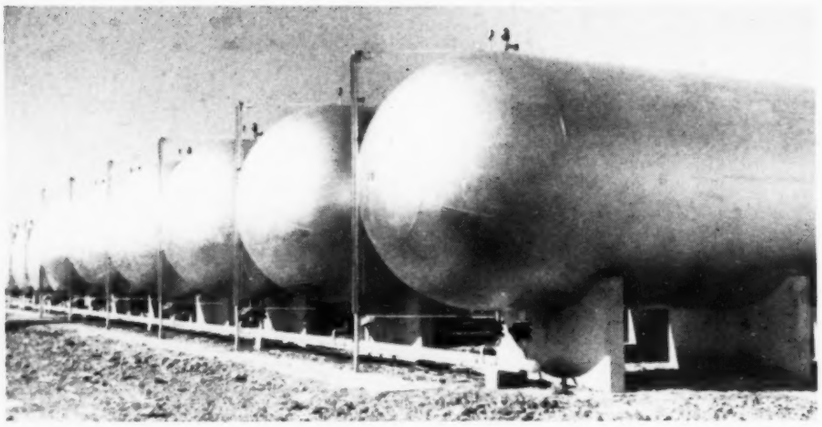
Major items of equipment, including names of manufacturers, follow:

American Hammered Piston Ring Division of Koppers Company—Gas-engine piston rings.

American Meter Company—Portable meter.

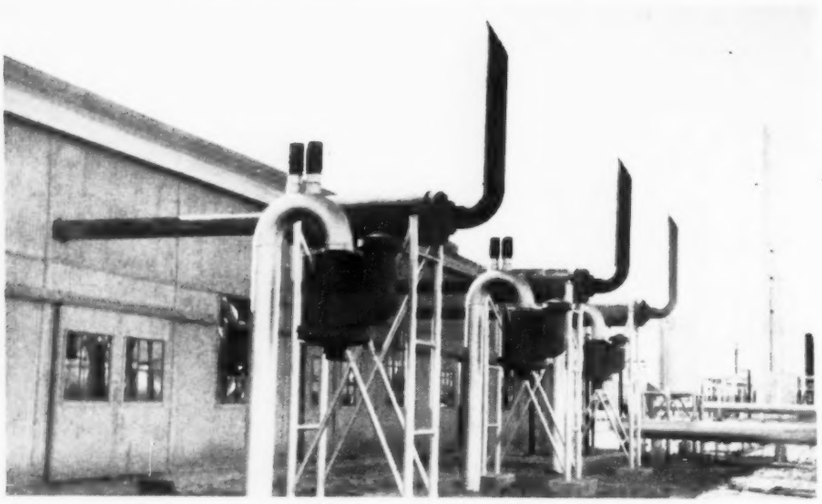
Bartlett Hayward Division of Koppers Company—Fast's flexible couplings.

Bethlehem Supply Company—Low-pressure pipe and fittings.



From the stabilizer the 410-endpoint motor fuel passes to these stock tanks

Air filters and silencers on compressor engines



Black, Sivalls & Bryson—Safety heads.

Brown Instrument Company—Controls.

J. A. Campbell Company—Boiler feedwater level controllers.

Coastal Fence Company—Fence.

Columbia Electric Manufacturing Company—Generator.

Consolidated Ashcroft Hancock Division of Manning, Maxwell and Moore—Safety valves.

C. Lee Cook Manufacturing Company—Compressor piston rod packing and compressor piston rings.

Cooper-Bessemer Corporation—Compressor units, and gas engine driving high-pressure oil pump.

Crane Company—Valves and fittings.

W. H. Curtin & Company—Laboratory equipment.

Daniel Orifice Fitting Company—Check valves and orifice fittings.

Engineers & Fabricators, Inc.—Heat exchangers and coolers.

Fisher Governor Company—Controls.

Forney Engineering Company—Boiler burners.

Foxboro Company—Meters.

McCord Radiator & Manufacturing Company—Lubricators.

McEvoy Company—Christmas trees.

Merco Nordstrom Valve Company—Valves.

National Tank Company—Separators, absorbers, reabsorbers, stabilizer, and fractionator.

Oil Well Supply Company—Boilers, high-pressure pipe.

Peerless Pump Division Food Machinery Corporation—Deep well water pumps.

Penberthy Injector Company—Reflex and liquid level gauges.

Petro Chem Development Company—Stills (furnaces)

Sales Engineering Service Company—Insulation.

Technical Products, Inc.—Fire-fighting equipment.

Texas Water Supply Company—Water-well contractor.

Thornhill-Craver Company—Chokes and Unibolt couplings on producing wells.

Tube-Turns, Inc.—Welding fittings.

Union Steam Pump Company—Pumps.

Vortox Manufacturing Company—Air filters.

Waukesha Motor Company—Gas engines driving water well pumps.

Wyatt Metal & Boiler Works—Tanks.

Wynn Crosby Drilling Company—Drilling contractor.

H. B. Zachry Company—General contractor.

John Zink Company—Still burners.

☆☆☆

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Subsurface Flow in Condensate Sands*

☆ The proper completion of production and injection wells is emphasized—Control of wells should be studied carefully and the program adjusted on the basis of periodic tests

by John Breaker

Gasoline Plant Construction Corporation

IN ORDER to understand fully the importance of the subsurface flow in condensate sands in connection with cycling operations, one must first know the nature of the contents of the reservoir and its behavior under varying pressures and temperatures.

Only a few years ago when wells were first drilled that produced a water-white oil at high gas-oil ratios, it was thought that the reservoir contents consisted of an oil that was principally gasoline, and a wet gas. This is still the belief of the casual observer and the average oil-field worker who, nevertheless, is beginning to have some knowledge of the true nature of the content of the wellhead product. In fact, it is now generally known that the fluids produced in such wells are wholly in the vapor phase in the reservoir.

In some sands, principally those found in the Gulf Coast area, the wet gas occupies the entire formation. In other sands the wet gas that has been processed for its gasoline content is only a gas cap overlying a heavier oil pool in the same formation. Kettleman Hills (California) and the Oklahoma City fields are two of the better known examples of this type. In other fields the oil occupies only a very narrow band around the border of the structure. These condensate sands vary in thickness from about ten to several hundred feet. The condensable content has been found to vary within the approximate range of 0.5 gal. per M. cu. ft. to 4.5 gal. per M. cu. ft.

The production of a liquid from these wells is due to retrograde condensation. Ignorance of this phenomenon was the reason for the early erroneous ideas concerning the existence of gasoline pools and was also responsible for the loss of millions of gallons of gasoline. Retrograde condensation is in direct opposition to the well-known gas laws that hydrocarbon mixtures obey at low pressure. In general, when hydrocarbon gases at low pressure are compressed at a constant temperature they are condensed into liquids. When the pressure is increased still further, however, to more than 1000 lb. per sq. in., the mixture will vaporize again, due to retrograde condensation. Conversely, gaseous mixtures at high pressure will condense when the pressure is released. The range of pressures above the point at which this reverse vaporization begins is known as the retrograde region. The pressure at which it becomes effective is known as the retrograde point.

Retrograde condensation applies only to a mixture of gases and not to a pure substance. There has been experimental evidence that at still greater pressures normal condensation is again effective. Thus far, this theory has not been tested thoroughly in practice, but it may be adapted to actual conditions as deeper drilling becomes more widespread and higher-pressure sands are tapped.

The produced condensate begins to form as the gas first enters the well bore. This is due to expansion and cooling as the gas comes from the sand into the well bore. Condensation continues as the fluid travels up the well bore due to further expansion, but principally because of the cooling effect of the strata encountered in the hole.

In condensate pools where pressure maintenance or cycling is not applied, the natural reservoir pressure drop due to gas production will cause enormous losses in recoverable condensate, because of the retrograde condensation that occurs throughout the entire sand. One of the better known examples of this is the La Blanca field in South Texas. At one time the reservoir pressure was 3800 lb. and the condensate content of the gas was 3.8 gal. per M. cu. ft. After much of the gas was blown to the air, the pressure declined to 2180 lb., and the condensate content was found to be only 1 gal. In other words, a pressure drop of 40 percent resulted in a production decline of 70 percent. There have been many similar cases in which ignorance of the phenomena of retrograde condensation has caused the loss of a veritable fortune in valuable condensate.

This type of condensation also explains some problems that puzzled the gas industry for several years, particularly in the gas fields of the Eastern States. In one field in West Virginia the wells would load up with condensate and seal off the flow of gas to such an extent that the wells had to be blown to the air for 45 minutes every day. This blowing would cause further condensation in the sand adjacent to the well bore so that after 24 hours the well would have to be blown again. Some of the old depleted gas sands have been used as storage space for gas that was returned underground. The operators hardly expected to recover as much gas as was injected, but instead they recovered more.

At first thought it might seem that if hydrocarbons are condensed in the reservoir when the pressure has been lowered, then a properly placed well would be able to produce this condensate. When one studies the volume of gas required to produce 1 gal. of con-

JOHN BREAKER

graduated from the University of Oklahoma in 1940 with degree in petroleum engineering—Employed by Coronado Corporation as operator in cycling plant at Woodsboro, Texas—Joined staff of Gasoline Plant Construction Corporation, Houston, Texas, in May, 1941.

*This paper was presented at one of the monthly meetings of the Petroleum Industries Association, a group of company engineers and others in the general vicinity of Corpus Christi, Texas, who are interested in studying some of the many drilling and production problems encountered in this strategic area.

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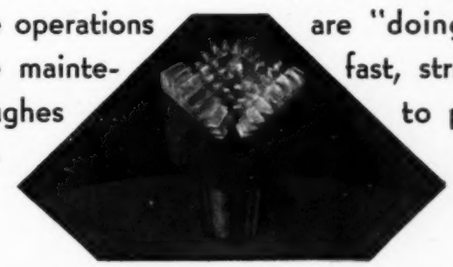

Hughes Tool Co., Houston, Texas

densate, however, it can be readily understood why this would be impossible. The condensate formed is only enough to wet the sand grains and none will settle to the lower part of the formation. The loss to be expected for any certain pressure drop in a given field can be determined by separator tests prior to the development of the field.

From the above discussion it should be evident that the only efficient means of operating a condensate recovery system is to maintain the reservoir at as near the original pressure as possible by the injection of the dry residue gas into the same formation from which it was taken. This cycling process, as it accurately is termed, serves four important purposes: first, it prevents the formation and subsequent loss of condensate in the reservoir; second, it drives nearly all the wet gas to the producing wells; third, it enables greater production rates from the wells by keeping a nearly constant high pressure on the sand, and fourth, it conserves the dry residue gas to be sold as fuel at a later date.

Diffusion

The first subject that had to be studied when cycling operations were first considered was the behavior of the dry gas after it was returned to the formation. Would the dry gas merely diffuse with the wet gas or would it drive the wet gas ahead of it away from the injection well? Nearly all the observed evidence so far indicates that there is very little diffusion, if any, although there undoubtedly may be some mixing of the gases due to differential velocities through a sand of varying permeabilities. (An article discussing the effect of velocity on mixing of gases has recently appeared.[1])

The lack of diffusion was shown on one test where gas was pumped into a well for about a month and then withdrawn at about the same rate from the same well. More than 90 percent of the dry gas was produced before it became any richer in condensable content. This should offer definite proof of the driving force exerted on the wet gas by the dry gas.

Another example that has furthered this belief is the pool in the Texas Panhandle that contains both sweet gas and sour gas. There is a definite contact line between the two gases, and this line shifts and can be predicted as gas is removed from either side.

Laboratory experiments to determine diffusion of gases in a porous medium were conducted at the University of Oklahoma with air and gas in a sand-packed tube. The experiments were performed at low pressures and did not duplicate actual conditions. These tests showed quite a bit of diffusion between the two gases, but it was found that diffusion decreased sharply as the pressure used in the test was increased. Even these experiments might indicate that at pressures of 2000 lb. or more there would be very little diffusion.

It seems certain that there will be dilution when there is a permeable streak in the sand, particularly when it is between the input and the production well. The velocity of the gas will be greater through the more permeable area and will cause a fingering of the dry gas into the wet gas area. This will take place to a greater extent when the wells are handling more gas. This channeling will be discussed further later in this article.

The same action may occur to a lesser extent along the entire contact zone of the gases, caused by the flow between the separate sand grains. The velocity will be greatest in the middle of the pore space and smallest adjacent to the grain or wall of the pore. As the first dry gas passes through a pore space, it will be joined in its course by a small part of the slower moving wet gas next to the sand grain. This effect is probably very small and the zone of mixtures should not be very wide under normal rates of subsurface flow.

Gas Patterns

The pattern or shape of the dry gas area in the reservoir can best be determined by electrical models. These models work on the principle that the potential differences in a properly designed electrical system are comparable to the pressure differences in the formation. The shape of the gas under a specified condition of well pattern and reservoir shape can be predicted by observing the flow. The model may be made in any shape desired so that the actual shape of the field in question can be duplicated. The causes of travel of the dry gas can be followed and often its exact position in the formation can be determined from the advancement in the electrical model. Allowances may also be made in the model for tight spots in the sand.

Well Patterns

In choosing the location for the injection and the production wells, each field must be studied separately. Although many pools are of approximately the same shape, irregularly shaped fields are often encountered that require unusual well arrangements. Before locations are made it is absolutely essential to gather all the obtainable geological data on the structure. Among the factors to be considered are areal extent and shape of the productive formation, permeability, porosity, pressure conditions, uniformity, and edge water. These will vary with every field and no program should be selected before they are all considered.

In a pool that is round, or nearly round, the production wells are generally located along the edge of the field and the injection wells in the center. This type of pattern should provide the greatest possible displacement of wet gas with the least pressure drop. One advantageous method is to space the production wells over a wide area. This permits a better control of the shape of the dry gas region because one poorly spaced well will not hurt the others so much. It also is the best arrangement to overcome the effects of variable permeability in the sand, as the dry gas is being forced uniformly in every direction, rather than in just one direction as when the injection wells are placed at one end of the structure. With this type of well pattern, if only a few wells are used, say three or four on opposite sides of the structure, care must be taken not to produce at such a rate as to cause fingering toward each well. This would result in an unusually large loss of wet gas on the border of the pool between the wells. Another advantage of this method is the fact that usually the center of the structure is the thickest and the most permeable part. This would then be the ideal place for the injection wells, which handle more gas per well than the supply wells.

If the field is elongated, its major axis being several times the length of the minor axis, usually another type of spacing will prove efficient. Injection wells can be located at one end of the structure and the production wells at the other. Or if the field is large enough to warrant it, input wells may be placed at each end with supply wells between them. Unusually large structures of this shape may call for input wells at each end and also in the middle. One advantage of this arrangement over the one prescribed for round fields is the fact that there is less chance of isolating a large quantity of wet gas along the border of the productive zone. On the other hand, there is less control of the dry gas inasmuch as the supply wells are grouped together. Fingering or channeling to one well will likely shorten the life of the others also. Another disadvantage is the likelihood of faults in the structure running parallel to the long axis.

The presence of faults in the formation should be one of the controlling factors in placing wells. If it is known that faults are present, the well pattern should be planned so that the flow of gas will be perpendicular to the faults. This is another condition in

[1] "The Effect of Velocity on the Mixing of Liquids in Porous Media," by Velmar V. Hendrix and R. L. Huntington. *The Petroleum Engineer*, October, 1941.

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which accurate geological data are absolutely necessary.

In placing production wells on the edge of a structure, they should be placed far enough from the edge water so that water encroachment will not occur, yet close enough so that a large amount of wet gas will not be left after the wells have dried up.

Completion of Wells

The proper completion of wells in a cycling system cannot be overemphasized. Improper completion methods may well cause a large loss due to subsurface condensation, interfere with the smooth operation of the plant, and put an undue load on the compressors, as well as create other harmful effects.

One of the most popular methods of completing production wells, especially in the Gulf Coast area, has been to cement casing through the pay sand and perforate with numerous shots. Although this may be successful in some cases, it is probably not the best method. The sand should never be cemented-off, except where there are a considerable number of separate sands to be produced eventually from the same well. The best method would seem to be to cement the casing on top of the pay, then place a screen or slotted liner through the sand. Or if casing is run through the sand, it should be cemented only above the sand through open holes in the casing and perforated with a great many shots. When the sand is cemented and production obtained through perforations, the high velocities at the perforations necessary to produce the desired amount of gas will cause an abnormal pressure drop in this vicinity. This will result in condensation both in the sand, which will be lost, and also in the well bore, which will likely disturb plant operation.

The completion of input wells is much more important than that of supply wells. They handle more gas per well and a poor completion job will cause more trouble than on a producing well. Correct completion procedure is essential from the standpoint of maintenance of high pressure on the reservoir and in preventing compressor trouble. It is necessary to expose the maximum area of the gas sand to provide increased input capacity. It is imperative, therefore, that the sand not be cemented. In completing an injection well, care should be taken that no means is provided whereby dirt or mud can reach the exposed area of the sand after it is once cleansed. A mud cake on the face of the sand will greatly interfere with the passage of gas into the formation.

One of the most successful methods of completion is to set a large sized casing on top of the sand, underream to a still larger size, and set a liner and gravel pack. The well should be thoroughly cleansed by backflowing before being put into operation. The well should be equipped with tubing so that it may be cleansed if it ever gets clogged with mud or scale from the casing. Clean water or a mud acid has proved very helpful in washing the sand face after clogging. This should be followed by blowing, of course.

Production wells should always be equipped with tubing. The primary purpose of tubing in a condensate well is to provide sufficient velocity to remove all the condensate from the well bore. When production is from casing there is not sufficient pressure drop in the casing to keep the condensate from falling back into the well and sealing-off the gas flow. That is, unless unusually large rates of production are used. The proper sized tubing must be determined from the desired rate of production.

Well Spacing

Well spacing in a condensate field is dependent upon several factors just as is the well pattern. The number of acres per well may approximate that used in a dry gas field. Spacings of as large as 300 acres have been used, but no set rule can be applied in this matter. One of the most important factors in spacing is the uniformity of the permeability of the formation. When permeable streaks are present, sufficient wells should be used so that the possibility of channeling directly to a well will be lessened. The selection is largely a matter of economics. As many wells should be drilled, however, as seem economically plausible because a large number of wells is a definte assurance that a high recovery percentage will be realized. There will be less space in the reservoir to form a possible isolated wet gas area, and the production from each well will be smaller and thereby minimize the possibility of channeling. Channeling is much more likely when the wells are flowing at high rates. This causes the pressure gradients around the well to be steeper and this tends to direct the flow from the input well directly to the supply well. Such channeling can easily reduce the life of a plant with a loss greater than the cost of additional wells that would have prevented it. In some of the larger projects, wells are flowed at rates as low as 2,000,000 cu. ft. per day and not more than eight or ten million.

Control of Wells

The control of the wells after the plant has been put into operation, like all the other problems, must be determined separately for each field. When the formation is uniform, the control is usually a simple matter. The flow from each well should be the same so that the dry gas will advance toward the wells at an equal rate and follow its predetermined pattern. When the permeability is not uniform, however, and the potentials of the wells are not the same, there is the question of whether to produce the wells equally or according to their potentials. When flowed in accordance with potentials, there will likely be less pressure drop and condensate loss in the sand, but there will be greater chance of channeling to a well of high potential. The loss due to condensation would ordinarily not be nearly as great as the loss caused by channeling, so it would seem that the wells should be flowed equally. It is possible that a condition of structure and well pattern could exist, however, whereby it would be best to let a well dry up quickly and then abandon it or use it as an injection well. A method of control should be decided upon only after all the conditions of the well pattern and reservoir are studied.

In one instance, where an area of high permeability was known to be present between an injection and a supply well, the problem was solved by injecting a quantity of clear water into the injection well. The water will seek the area of greatest permeability and stay there, preventing the gas from bypassing through it.

An important phase of well control is testing. Tests should be made regularly and frequently. In this way reservoir conditions can often be determined and serious trouble sometimes prevented. It is helpful to plot results of tests in order to observe the trend of the well.

All these tests need not be complicated. Before a well begins drying up, some idea as to its comparative content can be had by merely finding the endpoint of the condensate. This will not necessarily be true after dry gas reaches the well. The encroachment of dry gas may increase the bottom-hole pressure and vaporize around the well bore.

If a bottom-hole pressure bomb is not available or if a quicker method is desired, the pressure may be computed from the static wellhead pressure. This will require shutting in the well until the full static pressure has built up. It can then be determined by calculating the pressure exerted by the column of gas in the well and adding it to the wellhead pressure.

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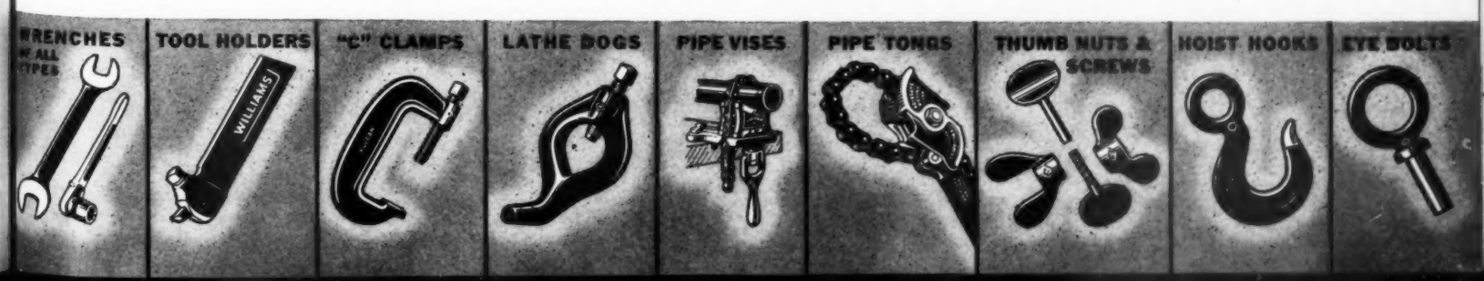


Elements of Orifice Meter Operation and Maintenance

PETROLEUM ENGINEER Exclusive Feature

Part 3 (Concluded)

by J. W. J. Bercher

Tide Water Associated-Seaboard Oil Company

A photograph and biographical sketch of the writer can be found on page 86 of the November issue of *The Petroleum Engineer*, in connection with Part 1 of this article.

Changing Charts

AT FIRST glance it would seem that anyone could in one easy lesson learn all about changing charts—just take one off and put the other one on. But that is not nearly all that should be done. The things the chart changer must observe are as follows:

1. When lifting pens avoid bending them.
2. Be sure chart is gripped firmly at hub.
3. Be sure pens are properly inked.
4. Be sure pens are marking.
5. Be sure chart is set to proper time.
6. Be sure there are no leaks in meter or manifold.
7. Be sure door of meter is tightly closed.
8. Be sure temperature noted on chart is correct.
9. Be sure any condition that may affect record is noted on chart.
10. Be sure chart is properly marked showing location.
11. Be sure chart is dated properly.
12. Be sure proper chart is on meter.
13. Be sure clock is wound.

The items listed are not in any particular order of importance. All are equally important but the ones listed first are more likely to be disregarded and are a more constant source of error than are the ones at the last.

When pens are lifted and the old chart removed and a new one installed the pens are in the way, and if the chart changer is in a hurry they may easily be bent. In extreme cases the pen may be bent so that it will not touch the chart; in most cases the result is a change of calibration that may go unnoticed for some time, introducing an error in the volumes calculated. There is nothing that can add more to the cost of meter maintenance than a pen-bending chart changer.

On some meters the locking device at the hub is nearly foolproof; on others it requires considerable care, but however much trouble it may require, the chart must turn if records are to be made. The chart changer in the field should always take time to be sure that the chart is turning and the plant operator should always check his meters not less than once each tour. The various means provided for holding the charts flat upon the back plate are not placed upon the meter as ornaments. They have a job to do and the chart is not properly installed if it is not held flat by the means provided.

The pens must be properly inked; that is, they must be properly filled with ink of the proper color. Failure to put ink of the proper color into each pen may easily lead to rather large errors with the old type chart if the static and differential readings were confused. In the case of the L-10 chart, no error in volume will result but a check on conditions might lead to serious trouble. The amount of ink is important; one drop is usually enough where flows are uniform and an excessive amount leads to danger of blotting the chart with consequent loss of record. Care must be taken that the pen lifter does not contact the chart lest it smear the chart.

Before you leave the meter be sure that the pens are marking. Failure of pens to mark may be caused by failure to depress the pen lifter, by dirty pens, or by oily charts. A tendency to blot may be caused by an overfull pen or by a dirty pen. The ink is corrosive in character and will eventually destroy the pen but one should not wait until the pen drops off to make a note on the chart so that a new pen may be provided.

Be sure that the chart is properly set for time. (The differential pen will be used as the time pointer and there should be 15 minutes between the pens at the zero line. If the spacing is more or less, note that upon the back of the chart.) Errors of 12 hours are most common when charts are changed. This error will not affect the volume for the total period but it may cause serious errors in checks on conditions at a specific time since quite often it is nearly impossible to tell just where the chart was put on. When several meters are used, all using different charts, errors of this kind are very common and can be prevented only by proper care on the part of the chart changer. If a chart is put on 12 hours in error, a checkup as it comes off should reveal the error and a note should be made calling attention to the condition.

At the time the charts are changed a check should be made for leaks in piping, manifold, and meter. A common source of leaks are the packing glands on the various needle valves. Such leaks should be stopped by the chart changer unless it is necessary to repack the gland in which case a note should be made on the back of the chart. Leaks in the meter or meter piping should be noted and left for the meter repairman except in cases of loose unions, etc., which may be tightened by the chart changer.

Moisture in the meter case may cause faulty records and will hasten clock failures due to corrosion. For that reason doors should be tightly shut and the gaskets in good condition. If evidence of leaks is found a note should be made.

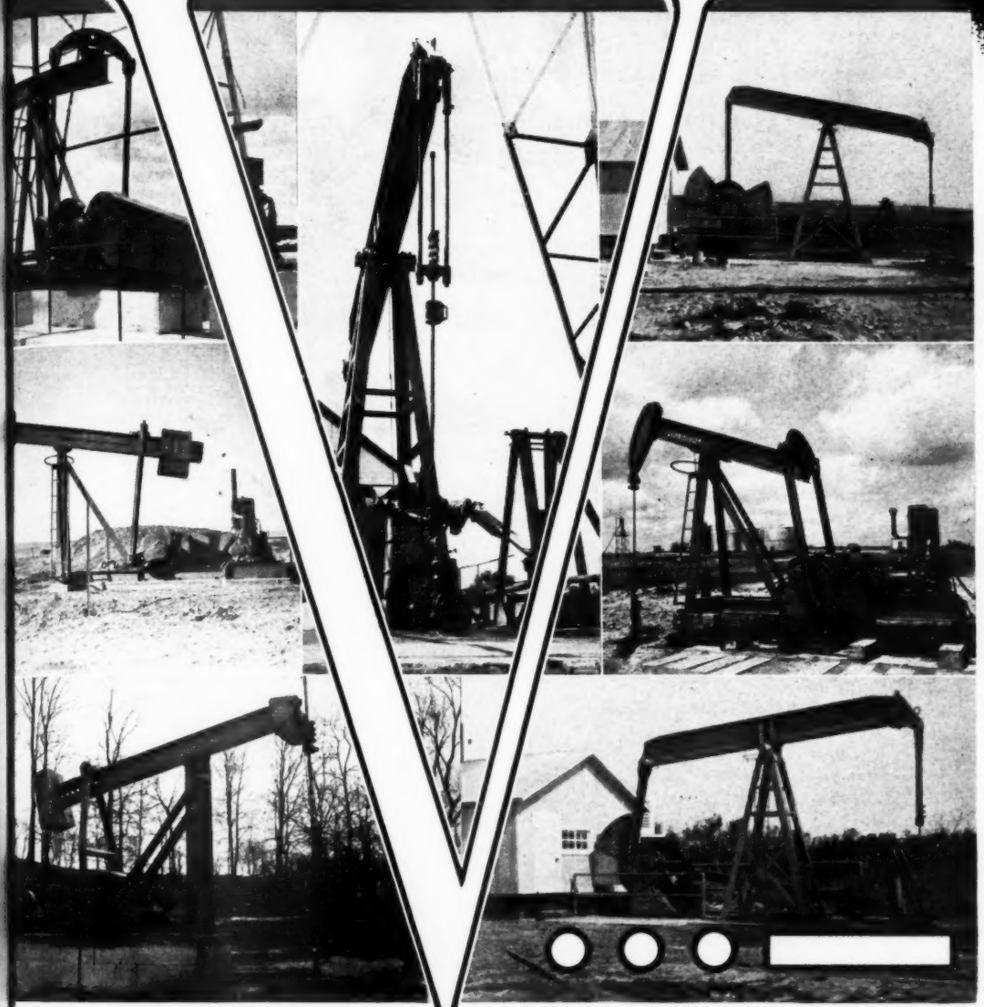
Reasonable care should be taken to insure that the temperatures shown are correct, as the effect of error is about 1 percent per 10°F.

Be sure before leaving the meter that all pertinent facts that should be brought to the attention of the chart reader or meter repairman are noted. Failure to do so may result in errors in volume.

It is necessary that each chart be properly dated and that the proper location be shown. Each meter chart is a potential piece of legal evidence and care must be taken that every chart turned in can speak for itself in court of law. It is well also to initial each chart changed to avoid any confusion concerning responsibility.

Check each time a chart is changed

Vital To Victory



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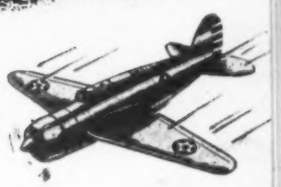

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	TU24G-JD2TP	TU44G-HD4TP	TU104G-HD10TP	TU164G-HD16TP	*TU164-HD16TB	TU234G-JD23TP	*TU234-JD23TB	*TU304-HD30TB
API Walking Beam Rating, Inches	3200	4300	6725	8900	8900	9125	9125	12750
Peak Torque Rating, Inch lbs. at 20 SPM	6360	11050	24300	40200	40200	57200	57200	76500
Overall Gear Ratio	26.0	29.5	29.2	29.2	29.2	29.8	29.8	29.6
Max. Polished Rod Stroke, Inches	16	20	28	34	34	42	42	48

*Equipped with National Eccentric Cranks and Counterweights—other sizes have beam type Counterweights.

TYPES FOR MEDIUM TO HEAVIEST SERVICE

BRIEF SPECIFICATIONS

Single Reduction Types	TU464-H46TB	TU683-H60T	TU683-H80T	TU803-H80T	TU803-H110T
Double Reduction Types	TU464-HD46TB	TU683-HD60T	TU683-HD80T	TU803-HD80T	
API Walking Beam Rating, lbs.	15000	18850	18750	24000	24000
Single Reduction Type: Peak Torque Rating, Inch lbs. at 20 SPM	124000	170000	238000	238000	303000
Overall Gear Ratio	10.2	9.7	9.4	9.4	9.32
Double Reduction Type: Peak Torque Rating, Inch lbs. at 20 SPM	113000	139000	200000	200000	—
Overall Gear Ratio	30.8	26.8	28.3	28.3	—
Maximum Polished Rod Stroke, Inches	54	54	64	72	72

All the above types have National Eccentric Cranks and Counterweights.

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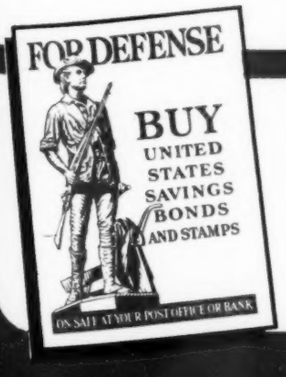

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to be sure that the proper chart is upon the meter. Meter charts from different manufacturers are not interchangeable and although a chart can be read when placed upon the wrong meter it requires more time and is more subject to error.

Be sure that you have wound the clock before you leave. A 24-hr. clock will rarely run for 48 hours on one winding and if the chart stops turning we have no record.

Zeroing A Meter

The most sensitive part of the meter is the differential gauge or U-tube. As might be expected, it is the part most frequently out of calibration. To get the U-tube back in calibration is usually quite simple. It is this process of recalibrating the U-tube that we refer to when we speak of "zeroing the meter." A meter is properly zeroed when the differential pen is at rest on the zero line of the chart and the pressure is the same on each side of the mercury column. The basic mechanical features of all meters are the same and all are zeroed in the same way; that is, by equalizing the pressures on the U-tube. The details of construction vary somewhat so that valve manipulation may be a little different but if the basic principles are understood, any meter may be properly zeroed. Refer to Fig. 11.

In Fig. 11, when valves A and C are open and valve B closed, the U-tube is in operation and registers the differential between M and N. If valve B is now opened and valve C closed, the pressure at M is transmitted to both sides of the U-tube and the liquid levels will be equal and the tube is zeroed. To put the tube back in service, open C and close B. This hookup is very simple and is sometimes used, but it will be noted that there is no provision for taking the pressure off the tube. Because it is sometimes necessary to bleed the pressure off, a modification of the hookup is used. In Fig. 12 a manifold is shown that will permit the pressure to be bled down. To zero this tube, close B, open A and C, and close E or F. If E is closed, the pressure at M is on the tube; if F is closed the pressure at N is on the tube. To bleed off the pressure close B, open A and C, close E and F, and open B slowly, allowing the pressure to bleed off. To put the tube back in service with E and F closed and with A, B, and C open; close B and crack E slowly open until full pressure is on tube, then open F, close A and C, and open B.

All the above can be condensed into a very short statement. To zero a meter put the same pressure on each side of the U-tube. Never open or close a valve quickly in zeroing. Remember these two things and you can't go wrong if you stop to trace out your piping before you start.

Operator's Responsibility

In tour work, during each operator's tour of duty he is responsible for the meter records during that tour just as much as he is for the gauges on the stock tanks. The production in the tank is dependent upon the gas processed and the operation of the plant is reflected in the yield in gal. per M. cu. ft. (G. P. M.) The yield cannot be accurately calculated until both production and gas volume are accurately known, and until the yield is found, the plant efficiency cannot be known. To know how many gal. production was made during a tour means little unless it is known how many M. cu.

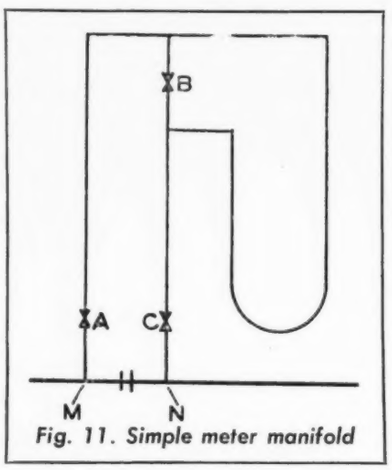

Fig. 11. Simple meter manifold

ft. of gas has been metered. The operator can know the G. P. M. by estimating the gas volume and working out the equation:

$$\text{G. P. M.} = \frac{\text{Prod.}}{\text{M. cu. ft.}}$$

When he does this he knows how efficiently the plant has operated during his tour; otherwise he can only guess.

To insure that the G. P. M. can be found he must exercise care to insure that the meters leave an accurate record during his tour. Checkups should be made to ascertain that the chart is turning, that both pens are marking, and that the record is correct. This doesn't mean that the meter must be zeroed each tour, but it does mean that a check should be made for leaks or for a frozen meter. A frozen meter usually will over-range or under-range (that is, the differential will be off the chart one way or the other) and the meter will not zero. If this condition is found, check the other meters to be sure they do not show a corresponding change in flow. If the other meters remain nearly constant, set the valves to zero the frozen meter. If it does not zero, close off both pressure taps and bleed off the pressure very cautiously. As the pressure is bled off, hydrates will usually be blown from the meter manifold and pens will come to zero.

Put the meter back in service and place a note on the chart showing the cause of the trouble. In some cases both arms of the U-tube will freeze; in this case the trouble may be harder to detect but it may be corrected in the same manner as above.

Any accumulation of liquids at the orifice plate will cause an error in the meter records. Drains are provided under each pressure tap to allow such liquids to be blown out. These drains should be blown often enough to remove any accumulation of liquid. No hard and fast rule can be laid down for this blowdown, some lines requiring attention more often than others. It will be necessary to find by experiment how often the drains should be opened to insure good metering.

Chart Reading

After the chart is made it is sent to the office, "read," and the volume of gas calculated. Although one may never have occasion to read a chart it is easier to understand the care of the meter if the process of chart reading is at least generally understood.

The equation upon which we depend in calculating charts is:

$$Q = C_o\sqrt{h_w P_f}$$

where:

Q = volume in cu. ft. per hr.
C_o = orifice coefficient for 1 hour.
h_w = differential in inches of water.
P_f = flowing pressure in lb. per sq. in. absolute.

The terms h_w and P_f are generally understood and C_o is figured in the office from formulas set up by the American Gas Association for nonstandard pipe sizes or taken from the meter company handbooks for standard sizes. A complete discussion of these formulas is beyond the scope of this paper. Appendix B of the A. G. A. Gas Measurement Committee Report is recommended to those who wish more detailed information. This report may be obtained from the office of the Association at 420 Lexington Avenue, New York, New York. Charts may be figured manually by intervals or by use of integrators or other mechanical devices.

The method of calculation by intervals will be treated in detail as it can be used in the field and requires no equipment. In using this method the static and differential are averaged by eye for hourly intervals if the flow is fairly uniform or by shorter intervals if necessary. In the standard type chart,

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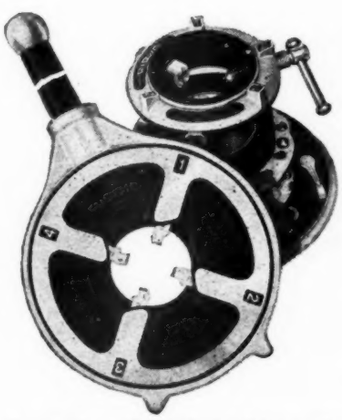

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h_w and P_f are read directly and substituted in the equation as read.

The first step is to begin at the time the chart was put on and in each hourly period set down the differential and static readings. When this is done, refer to the table of pressure extensions. In this table may be found the values of $\sqrt{h_w P_f}$ worked out. In the vertical column under the observed static pressure, drop down to the horizontal line for the observed differential; the value at this point is the pressure extension corresponding to the observed values. This value is set down for that hourly period and the process repeated on around the chart. When all the pressure extensions are set out they are added together and the result is the total pressure extension, which may be abbreviated Σ P. E. The symbol Σ is the Greek letter sigma and is used in mathematics as an abbreviation for "the sum of." So that Σ P. E. means the sum of the pressure extensions.

This pressure extension is then substituted in the basic equation $Q = C_o\sqrt{h_w P_f} \times F_{tf}$, where Q = volume of gas in cu. ft., C_o = orifice coefficient, $\sqrt{h_w P_f}$ = pressure extension, and F_{tf} = temperature correction factor.

Let us work out a sample reading to illustrate the procedure: Assume an hour on a chart during which the differential is 50 inches and the statc pressure is 1560 lb. per sq. in. The orifice coefficient is 671 and the temperature is 100°F. The first step is to determine the pressure extension corresponding to 50-in. and 1560 lb. Finding it to be 280.56, we then substitute in the equation $Q = 671 \times 280.56 \times F_{tf}$, or $= 188{,}256$ cu. ft. $\times F_{tf}$.

The factor F_{tf} is based upon a law of gases, which states that the pressure remaining constant, the volume varies as the temperature and vice versa. All of which boils down to the simple fact that if the temperature goes up either the volume or the pressure must also go up. Experiments have shown that the mathematical expression of this law may be stated by a definite formula and that all gases react very much in the same way when heated or cooled. The temperature 60°F. has been adopted by the gas industry as the base temperature or the temperature at which the gas is to be measured. Inasmuch as the gas at the meter is very seldom at exactly 60°F., the temperature correction factor is used to convert the metered volume to the volume that would be occupied by the gas if it were at 60°F. The value of $F_{tf} = \sqrt{\frac{520}{460 + T_f}}$, where T_f = the observed temperature at the meter in °F. In our problem $F_{tf} = \sqrt{\frac{520}{560}}$. This value may also be found in tables and in this case it is 0.9636. Then: $Q = 188256 \times 0.9636 = 181403$.

When Q is found it is expressed in M. cu. ft. and reported to the nearest 1000 cu. ft. After you have gone through all of the work shown above you may hesitate to "round out" the figure, but the M. cu. ft. is just as correct as your total value. For example, so far as meter work is concerned, 5,831 M. cu. ft. is just as correct as 5,831,499 cu. ft. would be. This is because in no case can we be sure of the value of our coefficients to more than four places.

From working out these values it will be apparent that all the data shown upon the chart must be correct if the final volume is to be correct. The effect of differential errors produces errors in volume ranging from 1 to 6 percent depending upon the value of the differential, a given error in calibration producing least effect when the differential is relatively great. Static errors are similar to differential errors but of less magnitude; errors of 1 percent in M. cu. ft. result for each 10° error in the temperature. When it is remembered that an orifice meter in good condition can check within 1 percent, carelessness becomes inexcusable. An orifice meter is potentially 99 percent accurate but it can be no better than the care it receives. An orifice meter installation costs $250.00 or more and all the care taken in setting it properly can be undone by failure to observe the rules of common sense when charts are changed. If not properly set and cared for, the accuracy of the resulting records may be so impaired that a guess at the flow may be more nearly correct.

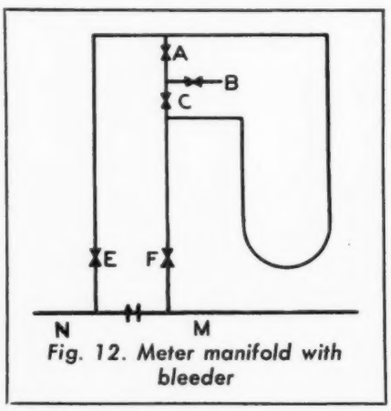

Fig. 12. Meter manifold with bleeder

Reading the Square Root Chart

The square root chart differs from the standard type chart in that the graduations upon the chart are equal to the square root of the percentage of the total range of the meter rather than in direct values. This makes the chart rather confusing at first glance but renders it very much easier to read.

An examination of the square root chart will not show separate differential and static scales as the percentage is the same on either. Because of this it will be necessary to use a formula to find the value of the differential and of the static. For 100-in. meters, the differential is equal to the differential reading squared; that is, a differential reading of 1 will equal 1×1 or 1 in. of water; a reading of 2 will equal 2×2 or 4 in. of water, etc. In reading the standard type chart we found that the static must be in lb. per sq. in. absolute; that is, gauge pressure plus one atmosphere (usually taken as 14.4 lb. per sq. in.) and the pressure extension is calculated to include the one atmosphere added. In using the square root chart the atmospheric correction is set up by zeroing the static pen at the proper value of atmospheric pressure above the zero line; the static indication is then truly at the absolute pressure. It becomes necessary at times to know the static pressure at the meter. To find the value the following formula is used: $P = (P_n^2 R_p/100) - 14.4$ where P = gauge pressure, P_n = square root chart static reading, and R_p = range of the static spring in lb. per sq. in. To illustrate let us take a reading 8.4 on a chart from a meter with a 2000-lb. spring and find the gauge pressure. Substituting in the formula:

$$P = \frac{8.4 \times 8.4 \times 2000}{100} - 14.4$$

$$P = \frac{70.56 \times 2000}{100} - 14.4$$

$$P = \frac{141{,}120}{100} - 14.4$$

$P = 1{,}411.20 - 14.4 = 1{,}396.80$ lb. per sq. in.

It is well to remember this formula in the event that you wish to check on line pressures during the tour and in order that you may check the meter while it is in service. On installations where there is a pressure gauge at the meter run, a periodic check of the calibration of the static of the meter may be made by comparing gauge pressures with static pressures through use of the formula. This checkup should be made by the chart changer at least once each week. By use of the formula a table of check readings may be set up from which comparisons may be made. Such a table will be found in the appendix. To use the table verify the range of the spring and under the proper value find the pressure corresponding to the static reading; the

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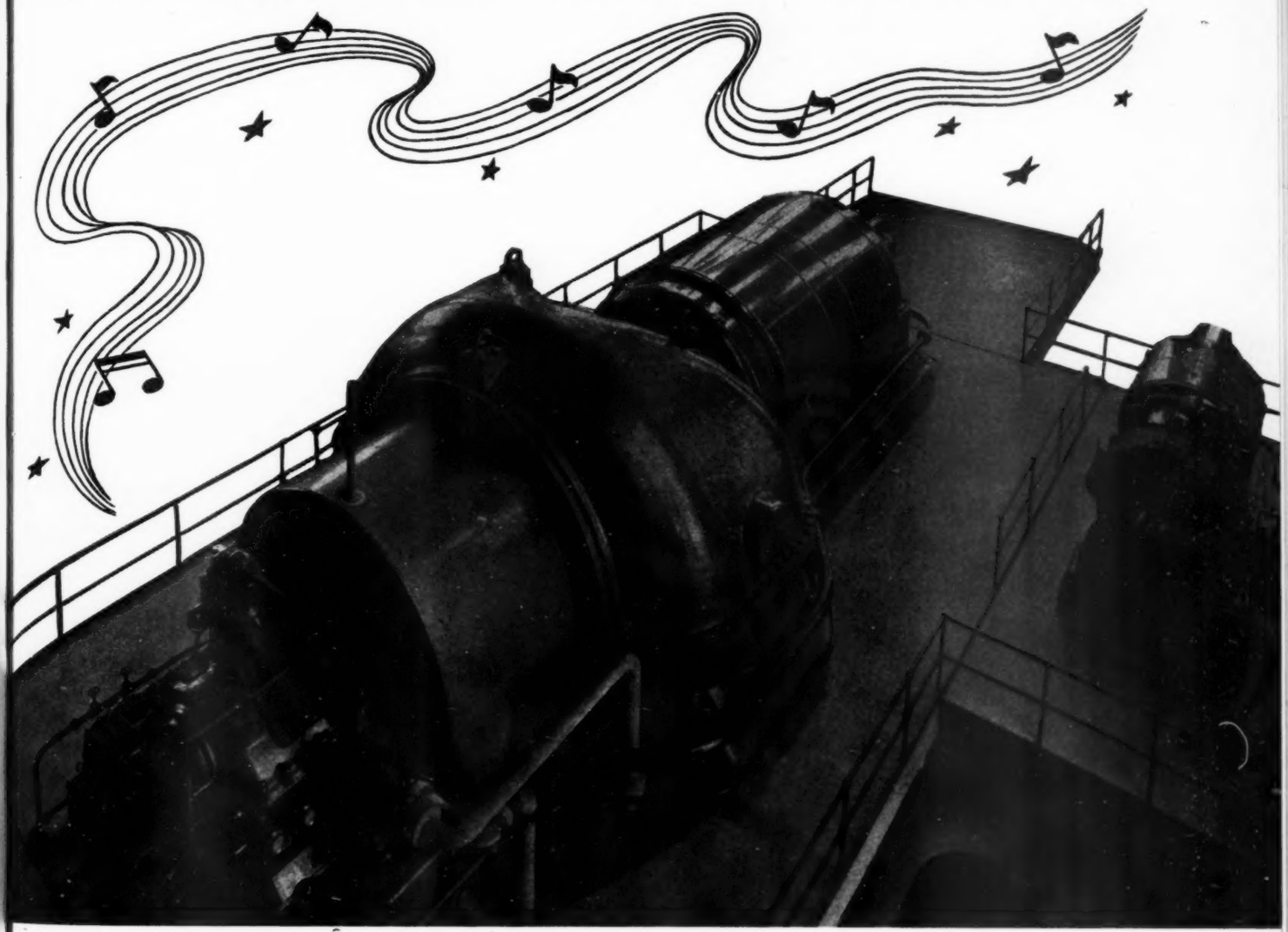

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gauge, if accurate, should correspond. If the values do not correspond, a note should be made on the chart in order that the meter repairman may check and find the error.

Because the square root chart scales read in square root of the percent of range, a coefficient must be used to adjust the value of the total pressure extension to a true relationship with the formulas from which the orifice factor is derived. This value, which is called the meter factor and is referred to as "M," is found from the following formula: $M = 0.01\sqrt{Rh_w \times R_s}$, where M = meter factor, Rh_w = range of the differential gauge in inches of water, and R_s = range of the static spring in lb. per sq. in. To illustrate the use of this formula let us take the case of a 100-in.-2000-lb. meter:

$M = 0.01\sqrt{100 \times 2000}$

$= 0.01\sqrt{200{,}000}$

$M = 0.01 \times 447.21 = 4.4721$

In practice, as M will be a constant value for any installation the orifice factor is multiplied by M and the product used as an orifice factor in computing square root charts.

After M is found and from M, C_m, (orifice factor for square root charts) the method of reading the chart is very much simplified. Inasmuch as the values on the scale are square roots of the percentage of range of the meter, it is only necessary to take the product of the differential and static readings for each hourly period; the sum of these products multiplied by C_m and by the proper temperature factor will give the volume. Expressed as a formula, this becomes:

$\Sigma P.E. = P.E._{.1} + P.E._{.2} \ldots . + P.E._{.24}$

$\Sigma P.E. \times C_m \times F_{tf} = Q$

$Q \div 1000 =$ M. cu. ft.

Note: The term P.E. in the above is equal to the product of the static and differential readings on the square root chart.

As an example let us calculate the flow for one hour on a typical meter setting. From the chart we find the differential to be 6.8 and the static to be 8.2; the flowing temperature is observed to be 98°F.; the orifice constant is 1013.82 and the chart is from a 100-in.-2000-lb. meter. The P.E. (L-10) will be 8.2×6.8 or 55.76.

C_m will be $1013.82 \times 4.472 = 4{,}533.80$

$Q = 4{,}533.80 \times 55.76 \times 0.9653 = 244{,}033$ cu. ft.

M. cu. ft. = 244

Then if this flow remained uniform for 24 hours, 5,856 M. cu. ft. would pass through the plate of this meter. The chief advantages of the square root chart lies in the simplicity of the calculation given above. The operator by remembering or marking down the average value of the factor C_m, may check at any time during his tour and determine the rate of flow through the plant. In the above case suppose that 4500 was taken as an average value of C_m, F_{tf} may be neglected and the operator will estimate the rate as follows: $8.2 \times 6.8 \times 4500 = 251$ M. cu. ft., which in this case is only about 3 percent in error. A 3 percent error would be more than could be allowed in calculating a chart but it is a negligible error in estimating the rate of flow from an operator's point of view.

If the differential and static pressures had been read to the nearest whole number, $8 \times 7 \times 4500$ would equal 252 M. cu. ft. and the error would still be only about 3 percent in this particular case.

If pressure extension tables were not available and the operator wished to estimate the flow from a standard type chart, it would require the following laborious process. The static would be 1330-lb. and the differential 46-in. From these values the P.E. would be:

$\sqrt{46 \times (1330 + 14.4)}$

1344.4
46
80664
53776
61842.4

Extracting the square root:

2 4 8. 4 7 7
$\sqrt{6\ 18\ 42.40\ 00\ 00}$
4
44 | 2 18
1 76
488 | 42 42
39 04
4964 | 2 38 40
1 98 56
49687 | 38 34 00
34 78 09
496947 | 3 55 91 00
3 47 86 29

Multiplying 248.5 by 1010*:

248.5
10 10
248 50
24850
250985.0

*"Rounding out" 1013.82

Although the longer method does not introduce appreciable error, the additional work required to read the static and differential on a square root chart seems more than justified considering the ease with which the rate of flow may be determined.

CHECK READING FOR L-10 CHARTS

	DIFFERENTIAL RANGE			STATIC RANGE		
Reading	*50-in.*	*100-in.*	*200-in.*	*2000-lb.*	*2500-lb.*	*3000-lb.*
1.0	0.50	1.00	2.00	5.6	10.60	15.60
1.5	1.12	2.25	4.50	30.6	41.85	53.10
2.0	2.00	4.00	8.00	65.6	85.60	105.60
2.5	3.12	6.25	12.50	100.6	141.85	173.10
3.0	4.50	9.00	18.00	165.6	210.60	255.60
3.5	6.12	12.25	24.50	230.6	291.85	353.10
4.0	8.00	16.00	32.00	305.6	385.60	465.60
4.5	10.12	20.25	40.50	390.6	491.85	593.10
5.0	12.50	25.00	50.00	485.6	610.60	735.60
5.5	15.12	30.25	60.50	590.6	741.85	893.10
6.0	18.00	36.00	72.00	705.6	885.60	1,065.60
6.5	21.12	42.25	84.50	830.6	1,041.85	1,253.10
7.0	24.50	49.00	98.00	965.6	1,210.60	1,455.60
7.1	25.20	50.41	100.82	993.6	1,245.85	1,497.90
7.2	25.92	51.84	103.68	1,022.4	1,281.60	1,540.80
7.3	26.64	53.29	106.58	1,051.4	1,317.85	1,584.30
7.4	27.38	54.76	109.52	1,080.8	1,354.60	1,628.40
7.5	28.12	56.25	112.50	1,110.6	1,391.85	1,673.10
7.6	28.88	57.76	115.52	1,140.8	1,429.60	1,718.40
7.7	29.64	59.29	118.58	1,171.4	1,467.85	1,764.30
7.8	30.42	60.84	121.68	1,202.4	1,506.60	1,810.80
7.9	31.20	62.41	124.82	1,233.8	1,545.85	1,857.90
8.0	32.00	64.00	128.00	1,265.6	1,585.60	1,905.60
8.1	32.80	65.61	131.22	1,297.8	1,625.85	1,953.90
8.2	33.62	67.24	134.48	1,330.4	1,666.60	2,002.80
8.3	34.42	68.89	137.78	1,363.4	1,707.85	2,052.30
8.4	35.28	70.56	191.12	1,396.8	1,749.60	2,102.40
8.5	36.12	72.25	144.50	1,430.6	1,791.85	2,153.10
8.6	36.98	73.96	147.92	1,464.8	1,834.60	2,204.40
8.7	37.84	75.69	151.38	1,499.4	1,877.85	2,256.30
8.8	38.72	77.44	154.88	1,534.4	1,921.60	2,308.80
8.9	39.60	79.21	158.42	1,569.8	1,965.85	2,361.90
9.0	40.50	81.00	162.00	1,605.60	2,010.60	2,415.60
9.1	41.40	82.81	165.62	1,641.80	2,055.85	2,469.90
9.2	42.32	84.64	169.28	1,678.40	2,101.60	2,524.80
9.3	43.24	86.49	172.98	1,715.40	2,147.85	2,580.30
9.4	44.18	88.36	177.72	1,752.80	2,194.60	2,636.40

This table of values covers operating conditions most frequently found. Check readings for conditions not shown may be calculated from formulas given in the section on L-10 charts.

Outstanding Union Wire Rope distributors throughout the country are backed up by two important forces for your convenience: (1) strategically located warehouses to insure prompt service, and (2) trained rope engineers available at all times to help solve your rope problems. This Service Map is your guide. Tear it out and keep it in your files to facilitate your future use of wire rope.

UNION WIRE ROPE CORPORATION

UNION Wire Ropes

The "ULTIMATE LOW COST WIRE ROPE"

The following analysis of the method of calculating square root charts will serve to illustrate the advantage of this type of chart in an office where an integrator is not available. Inasmuch as all readings are expressed as square roots of the percent of the total range of the instrument it follows that: At any time the instantaneous value of the

$$P.E. = \sqrt{\left(\frac{d}{100}\right)^2 D} \times \sqrt{\left(\frac{s}{100}\right)^2 S}$$

$$= \frac{d}{100}\sqrt{D} \times \frac{s}{100}\sqrt{S}$$

$$= \frac{ds}{100}\sqrt{D \times S}$$

where:
d = differential reading on chart,
D = differential range of meter,
s = static reading on chart,
S = static range of meter. For any period of time, say 24 hours,

$(\sqrt{d^2D} \times \sqrt{s^2 S})_1 + - - - - + (\sqrt{d^2D} \times \sqrt{s^2 S})_n = 100\ \Sigma P.E.$

Simplifying:

$(d s\sqrt{DS})_1 + - - - - - - - (ds\sqrt{DS})_n = 100\ \Sigma P.E.$

and upon factoring $\sqrt{DS}$:

$[(ds)_1 + (ds)_n] \times \sqrt{D S} = 100\ \Sigma P.E.$

If $s_1 = s_2 = s_3 = - - - s_n$ then:

$\sqrt{D S} \times s_n(d_1 + d_2 + d_3 - - - - + d_n) = 100 \Sigma P.E.$

If, however, S varies in value between narrow limits, then:

$S_{avg.}(d_1 + d_2 + d_3 - - - - + d_n)\sqrt{D S} = 100\ \Sigma P.E.$

or

$$S_{avg.}(d_1 + d_2 - - - - + d_n) = \frac{100 \times \Sigma P.E.}{\sqrt{DS}} = \Sigma P.E.$$

From our formula for calculating the square root chart: $Q = C_o \times M \times \Sigma P.E.$

Substituting the above value we have:

$$Q = C_o \times \sqrt{\frac{D S}{100}} = \frac{100 \times \Sigma P.E.}{\sqrt{DS}}$$

and upon simplifying we have:

$Q = C_o \times \Sigma P.E.$, the conventional formula. This means that the sum of the various hourly differential readings may be found and this sum multiplied by the average static reading to obtain the total pressure extension for the square root chart within reasonable limits of error.

Using this method with charts where flows are relatively steady it is often found that the use of an adding machine results in an actual loss of time; with a little practice the required sum of differentials may be read directly.

☆☆☆

P 951.1

Engineering Study Made of Anahuac Field, Texas

THE application of improved engineering methods for estimating recoverable petroleum from certain types of American oil fields, has been suggested by the U. S. Bureau of Mines as a result of studies based on modern technique in the drilling and development of a large oil field, Dr. R. R. Sayers, Director of the Bureau, has informed Secretary of the Interior Harold L. Ickes.

The Anahuac field in Chambers County, Texas, fourth ranking petroleum reservoir in that state's Gulf Coast fields, served as a model for the research because of its systematic development on the basis of good engineering practices since production began in 1935, Doctor Sayers said.

Owned and operated by less than half a dozen companies, the Anahuac wells produced nearly 15,000,000 bbl. of crude oil from March, 1935, to October, 1940. The producing area embraces 7300 acres and penetrates the Frio sandstone where the producing zone is 135 ft. thick.

Methods and formulas used to calculate the ultimate oil and gas recovery in this field are described in detail in a report that disclosed that "as a result of the refinement in estimates of reserves made possible by modern engineering technique," the porosity-saturation method was deemed most suitable for fields of this type.

In this method, the net volume of the producing formation in the reservoir is computed from subsurface records of the wells, whereas the porosity, saturation, and shrinkage of oil are determined by experiment or analysis. Recovery must be based upon the records of depleted or nearly-depleted fields having similar characteristics, or upon theoretical considerations.

Data and information pertaining to the development of the Anahuac field were collected and analyzed by Bureau engineers, with special emphasis upon modern technologic practices in drilling and operation. The scientific aids included coring; electric logging; micropaleontology; determination of porosity; permeability of oil-bearing sands and their connate water content; subsurface sampling of the reservoir oil, and depth pressure measurements.

"Every modern technique in drilling and developing has been applied at this field," the report stated. "Complete records of all operations, including detailed subsurface information, have been kept; the field has been developed systematically; and every effort has been made to utilize reservoir energy efficiently."

Results of this program have effected a slow, orderly withdrawal of crude oil that has provided "an exceedingly well-controlled upward movement of mobile connate water, as indicated by the fact that almost six years after the field was discovered, only 14 of the 385 wells were producing more than 2 percent water," the report revealed.

The oil-bearing part of the Frio reservoir is delimited by a gas-oil contact below. Most of the wells were drilled to a depth midway between the two contacts in order to obtain maximum benefit of gas expanding downward and the water moving upward. By conserving the free gas cap and maintaining a low rate of oil withdrawal, the reservoir should be kept under hydraulic control.

Regarding measurements of production, and curtailment by proration in the Anahuac field, the report stated:

"Initial daily oil production of all the Frio wells in the field measured through one-fourth inch diameter positive chokes, ranged from 29 to 799 barrels. The gas-oil ratios of production were close to the volume (498.5 cubic feet per barrel) of natural gas dissolved at reservoir temperature and pressure per unit of residual oil as determined on two samples of subsurface oil. Production in the Anahuac field has been curtailed as the result of proration, and the average daily production per well of all the wells in the field has not exceeded 119 barrels."

The oil and gas producing formations in most of the wells were cored and surveyed with electric logging devices, and the records were helpful in identifying oil-saturated strata and shale lenses. Laboratory analyses of four cores of the Frio sandstone that were cut while circulating an oil base, water-free drilling, showed a fixed connate water saturation of 50 percent, which is considered to be greater than the average for most oil-bearing sandstones, the report revealed.

A copy of the report may be obtained by writing for Report of Investigations 3579, "Petroleum Engineering Study of the Anahuac Field, Chambers County, Texas," by Charles B. Carpenter and H. J. Schroeder, to the U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 55

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

Nos. P000-P339—General
Nos. P400-P499—Drilling
Nos. P500-P599—Production
Nos. P600-P699—Transportation and Storage (includes Pipe Line)
Nos. P700-P799—Refining, including
Nos. P770-P799—Natural Gasoline, which may be classifed in a separate division (as shown here) if of special interest to the user

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To aid the reader in using the Decimal System, a subject index arranged alphabetically has been published, and is available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

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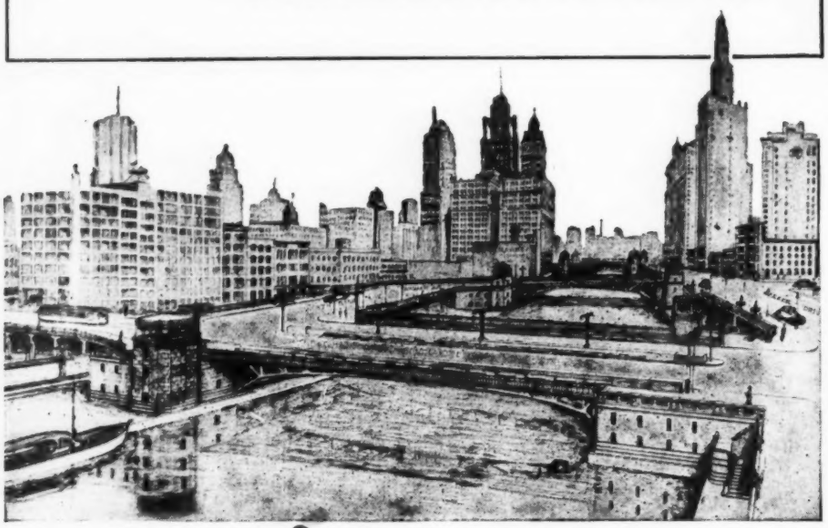
GRAVITY OF DRY OIL IN OIL-WATER MIXTURE

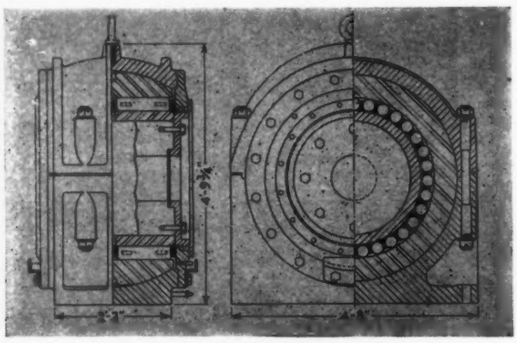
Gravity of "wet" oil deg. A.P.I.	Percent water in mixture														
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
55.0	**67.0**	**68.0**	**69.0**	**70.0**	71.1	72.2	73.4	74.6	75.8	77.1	78.5	79.9	81.3	82.8	84.4
.1	.2	.2	.2	.2	.3	.4	.6	.8	.9	.3	.7	**80.0**	.5	**83.0**	.6
.2	.4	.4	.4	.4	.5	.6	.8	.9	**76.0**	.5	.9	.2	.7	.2	.8
.3	.5	.5	.5	.5	.6	.8	.9	**75.0**	.2	.7	**79.0**	.4	.9	.4	**85.0**
.4	.6	.6	.6	.6	.7	.9	**74.0**	.2	.4	.8	.2	.6	**82.0**	.6	.2
55.5	67.7	68.7	69.7	70.7	71.8	**73.0**	74.1	75.4	76.6	77.9	79.3	80.7	82.2	83.8	85.4
.6	.9	.9	.8	.9	.9	.2	.3	.6	.8	**78.0**	.5	.9	.4	**84.0**	.6
.7	**68.0**	**69.0**	.9	**71.0**	**72.0**	.4	.5	.8	.9	.2	.7	**81.0**	.6	.2	.8
.8	.2	.2	**70.0**	.2	.2	.5	.7	.9	**77.0**	.4	.9	.2	.8	.4	**86.0**
.9	.3	.3	.2	.4	.4	.6	.8	**76.0**	.2	.6	**80.0**	.4	**83.0**	.6	.2
56.0	68.4	69.4	70.4	71.5	72.6	73.7	74.9	76.2	77.4	78.8	80.2	81.6	83.1	84.7	86.3
.1	.5	.6	.6	.7	.8	.9	**75.0**	.4	.6	**79.0**	.4	.8	.3	.9	.5
.2	.6	.8	.8	.9	.9	**74.0**	.2	.6	.8	.2	.6	**82.0**	.5	**85.0**	.7
.3	.8	.9	.9	**72.0**	**73.0**	.2	.4	.7	**78.0**	.4	.8	.2	.7	.2	.9
.4	.9	**70.0**	**71.0**	.1	.2	.4	.6	.8	.2	.5	.9	.4	.9	.4	**87.0**
56.5	**69.0**	70.1	71.1	72.2	73.3	74.5	75.7	76.9	78.3	79.6	**81.0**	82.5	**84.0**	85.6	87.3
.6	.2	.3	.3	.4	.5	.7	.9	**77.0**	.5	.8	.2	.7	.2	.8	.5
.7	.4	.4	.5	.6	.7	.8	**76.0**	.2	.7	**79.0**	.4	.9	.4	**86.0**	.7
.8	.5	.5	.6	.7	.8	.9	.2	.4	.9	.2	.6	**83.0**	.6	.2	.9
.9	.6	.6	.7	.8	.9	**75.0**	.4	.6	**79.0**	.4	.8	.2	.8	.4	**88.0**
57.0	69.7	70.7	71.8	72.9	74.1	75.2	76.5	77.7	79.1	80.5	81.9	83.4	84.9	86.6	88.3
.1	.8	.8	.9	**73.0**	.3	.4	.7	.8	.3	.7	**82.0**	.6	**85.0**	.8	.5
.2	.9	.9	**72.0**	.2	.5	.6	.8	**78.0**	.5	.9	.2	.8	.2	**87.0**	.7
.3	**70.0**	**71.0**	.2	.4	.6	.8	.9	.2	.7	**81.0**	.4	**84.0**	.4	.2	.9
.4	.2	.2	.4	.5	.7	.9	**77.0**	.4	.8	.2	.6	.2	.6	.4	**89.0**
57.5	70.4	71.4	72.5	73.6	74.8	**76.0**	77.3	78.6	79.9	81.3	82.8	84.3	85.9	87.5	89.2
.6	.6	.6	.7	.8	.9	.2	.5	.8	**80.0**	.5	.9	.5	**86.0**	.7	.4
.7	.8	.8	.8	.9	**75.0**	.4	.7	.9	.2	.7	**83.0**	.7	.2	.9	.6
.8	.9	.9	.9	**74.0**	.2	.6	.9	**79.0**	.4	.8	.2	.9	.4	**88.0**	.8
.9	**71.0**	**72.0**	**73.0**	.2	.4	.7	**78.0**	.2	.6	**82.0**	.4	**85.0**	.6	.2	**90.0**
58.0	71.1	72.2	73.2	74.4	75.6	76.8	78.1	79.4	80.7	82.2	83.6	85.2	86.8	88.5	90.2
.1	.3	.4	.4	.6	.8	.9	.3	.6	.9	.4	.8	.4	**87.0**	.7	.4
.2	.5	.6	.6	.8	.9	**77.0**	.5	.8	**81.0**	.6	**84.0**	.6	.2	.9	.6
.3	.6	.7	.8	.9	**76.0**	.2	.6	.9	.2	.8	.2	.8	.4	**89.0**	.8
.4	.7	.8	.9	**75.0**	.2	.4	.7	**80.0**	.4	.9	.4	**86.0**	.6	.2	**91.0**
58.5	71.8	72.9	**74.0**	75.1	76.3	77.6	78.8	80.2	81.6	**83.0**	84.5	86.1	87.7	89.4	91.2
.6	.9	**73.0**	.2	.3	.5	.8	.9	.4	.8	.2	.7	.3	.9	.6	.4
.7	**72.0**	.2	.4	.5	.7	.9	**79.0**	.6	.9	.4	.9	.5	**88.0**	.8	.6
.8	.2	.3	.5	.6	.8	**78.0**	.2	.7	**82.0**	.6	**85.0**	.7	.2	**90.0**	.8
.9	.3	.4	.6	.7	.9	.2	.4	.9	.2	.8	.2	.9	.4	.2	**92.0**
59.0	72.4	73.5	74.7	75.8	**77.0**	78.3	79.6	**81.0**	82.4	83.9	85.4	**87.0**	88.6	90.4	92.2
.1	.6	.7	.9	.9	.2	.5	.8	.2	.6	**84.0**	.6	.2	.8	.6	.4
.2	.8	.9	**75.0**	**76.0**	.4	.7	.9	.4	.8	.2	.8	.4	**89.0**	.8	.6
.3	.9	**74.0**	.2	.2	.6	.9	**80.0**	.6	.9	.4	.9	.6	.2	**91.0**	.8
.4	**73.0**	.2	.3	.4	.7	**79.0**	.2	.7	**83.0**	.6	**86.0**	.8	.4	.2	**93.0**
59.5	73.1	74.3	75.4	76.6	77.8	79.1	80.4	81.8	83.2	84.7	86.3	87.9	89.6	91.4	93.2
.6	.3	.5	.6	.8	**78.0**	.3	.6	**82.0**	.4	.9	.5	**88.0**	.8	.6	.4
.7	.5	.7	.8	**77.0**	.2	.5	.8	.2	.6	**85.0**	.7	.2	**90.0**	.8	.6
.8	.7	.9	**76.0**	.2	.4	.7	**81.0**	.4	.8	.2	.9	.4	.2	**92.0**	.8
.9	.9	**75.0**	.2	.4	.6	.9	.2	.6	**84.0**	.4	**87.0**	.6	.4	.2	**94.0**

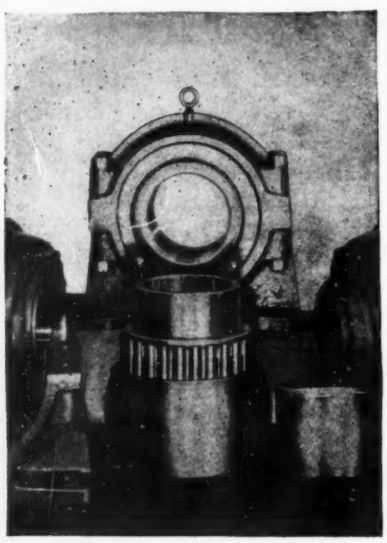
IN THE NEWS

WITH BANTAM BEARINGS

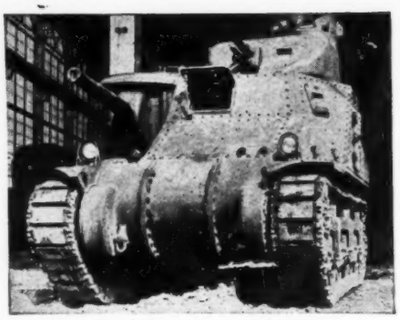


ENGINEERING ADVANCEMENT for new Chicago project is the use of radial roller bearings in the bascule type bridge now under construction for North State Street. The bridge, a perspective study of which is shown above, will rank among the largest of its kind in the world, with a width of 108 feet and a clear span of 210 feet. Two 36-foot roadways will be provided. Shown at left is cross-section of one of the large (47½" O.D.) Self-Aligning Roller Bearings, designed and built by Bantam, which will support two sets of three trunnions which in turn will carry the two movable leaves weighing 8,500,000 lbs. each. Self-aligning features, provided by spherical outer races resting in spherical housing seats, will compensate for any possible load deflections that may take place—another example of Bantam's engineering skill in designing anti-friction bearings for new and unusual requirements. Furthermore...

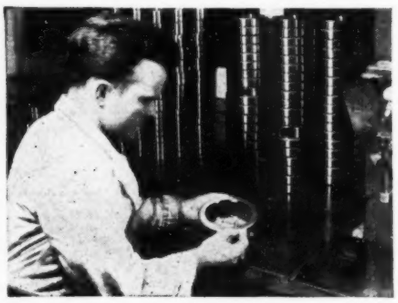




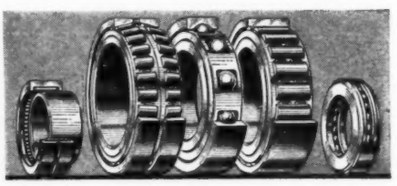
Substantial savings in size of electrical equipment and in power operating costs will be made through the use of Bantam Radial Roller Bearings. Only four 75 HP series motors will be required to operate the bridge, while the lower servicing and maintenance requirements of these bearings will bring additional savings. Bantam Bearings, such as those shown at left, have already been applied with gratifying results in other types of bridges. Breakaway and running loads have been reduced, and spans are moved with greater ease.



"BIG BRUISER" is this M-3 28-ton tank shown leaving the assembly line of the Chrysler Tank Arsenal. In the transmission, Bantam's Quill Roller Bearings aid in passing the tremendous driving power from motor to tractor treads. Maintaining a prompt, efficient flow of bearings of all types to the assembly lines of industry is Bantam's first job in helping meet the demands of the rapidly increasing production of defense material.



THE MANY ADVANTAGES of Bantam's compact, high capacity Quill Bearing are making it increasingly in demand for defense needs, where dependability and long-time maintenance-free service are primary considerations. A self-retained unit, easily installed and lubricated, it is ideally adapted to production line assembly methods. And its small size permits savings in materials of surrounding parts. For details on this unusual bearing, write for Bulletin **P-104.**



FOR OIL WELL EQUIPMENT, Bantam makes *every* major type of anti-friction bearing—straight roller, tapered roller, needle, and ball. If you have a difficult problem, TURN TO BANTAM.

BANTAM BEARINGS

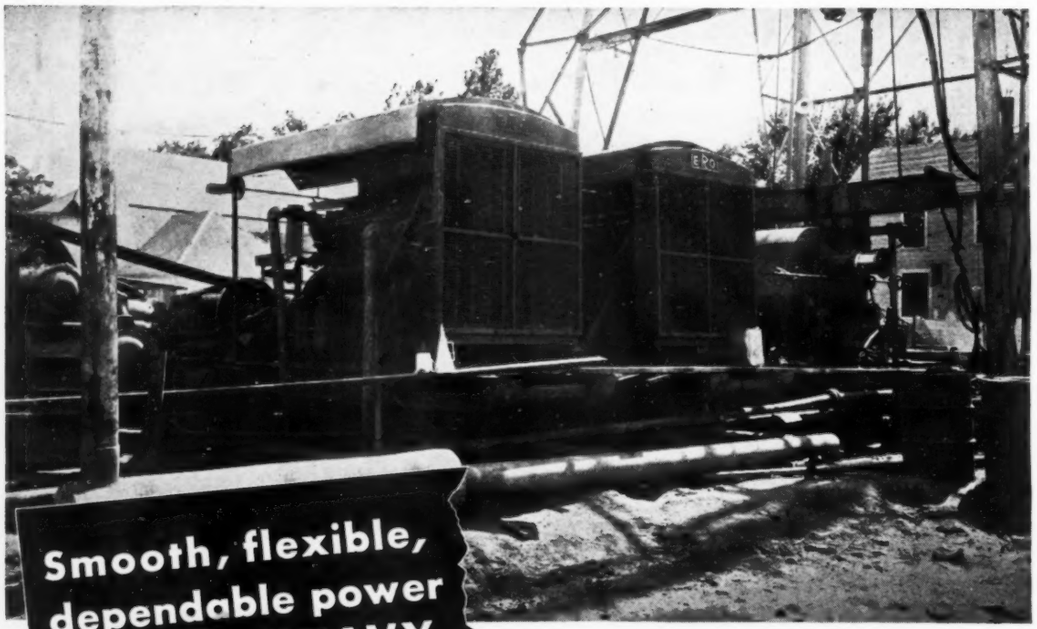
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

CONVERSION TABLES—FOREIGN WEIGHT UNITS

Multiply Quantity of:	By	to obtain the quantity of:
Arobe (Paraguay) or Arroba (Argentine Republic)	25.32	Pounds (U.S.)
do	11.485	Kilogram
do	0.0115	metric ton
do	0.0127	ton short or net
do	0.0113	ton long or gross
Arratel or libra (Portugal)	1.012	pounds (U.S.)
do	0.4590	kilogram
do	0.0005	metric ton
do	0.0005	ton short or net
do	0.0005	ton long or gross
Arroba (Brazil, Portugal)	32.38	pounds (U.S.)
do	14.687	kilogram
do	0.0147	metric ton
do	0.0162	ton short or net
do	0.0145	ton long or gross
do (Cuba)	25.366	pounds (U.S.)
do	11.506	kilogram
do	0.0115	metric ton
do	0.0127	ton short or net
do	0.0113	ton long or gross
Arroba (Spain)	25.36	pounds (U.S.)
do	11.514	kilogram
do	0.0115	metric ton
do	0.0127	ton short or net
do	0.0113	ton long or gross
Artel (Morocco)	1.12	pounds (U.S.)
do	0.5080	kilogram
do	0.0005	metric ton
do	0.0006	ton short or net
do	0.0006	ton long or gross
Batman (Tabriz) (Iran)	6.55	pounds (U.S.)
do	2.9710	kilogram
do	0.0030	metric ton
do	0.0033	ton short or net
do	0.0029	ton long or gross
Berkovets (Russia)	361.2	pounds (U.S.)
do	163.84	kilogram
do	0.1638	metric ton
do	0.1806	ton short or net
do	0.1612	ton long or gross
Candy (Bombay) (India)	784.	pounds (U.S.)
do	355.61	kilogram
do	0.3556	metric ton
do	0.3920	ton short or net
do	0.3500	ton long or gross
Candy (Bombay) (India)	569.	pounds (U.S.)
do	258.05	kilogram
do	0.2581	metric ton
do	0.2845	ton short or net
do	0.2540	ton long or gross
Candy (Madras) (India)	500.	pounds (U.S.)
do	226.80	kilogram
do	0.2268	metric ton
do	0.2500	ton short or net
do	0.2232	ton long or gross

Multiply Quantity of:	By	to obtain the quantity of:
Cantar (Morocco)	113.	pounds (U.S.)
do	51.256	kilogram
do	0.0513	metric ton
do	0.0565	ton short or net
do	0.0504	ton long or gross
Cantar (Damascus) (Syria)	575.	pounds (U.S.)
do	260.81	kilogram
do	0.2608	metric ton
do	0.2875	ton short or net
do	0.2567	ton long or gross
Cantar (Turkey)	124.7036	pounds (U.S.)
do	56.563	kilogram
do	0.0566	metric ton
do	0.0624	ton short or net
do	0.05567	ton long or gross
Cantaro (Cantar) (Malta)	175.	pounds (U.S.)
do	79.378	kilogram
do	0.0794	metric ton
do	0.0875	ton short or net
do	0.0781	ton long or gross
Catty (China)	1.3333	pounds (U.S.)
do	0.6046	kilogram
do	0.0006	metric ton
do	0.0007	ton short or net
do	0.0006	ton long or gross
Catty (Sumatra)	2.12	pounds (U.S.)
do	0.9616	kilogram
do	0.0010	metric ton
do	0.0011	ton short or net
do	0.0009	ton long or gross
Catty (Java, Siam, Malacca)	1.36	pounds (U.S.)
do	0.6169	kilogram
do	0.0006	metric ton
do	0.0007	ton short or net
do	0.0006	ton long or gross
Coyan (Sarawak)	3098.	pounds (U.S.)
do	1405.2	kilogram
do	1.4053	metric ton
do	1.5490	ton short or net
do	1.3829	ton long or gross
Coyan (Koyan) (Siam)	2667.	pounds (U.S.)
do	1209.7	kilogram
do	1.2097	metric ton
do	1.3335	ton short or net
do	1.1905	ton long or gross
Fanega (dry) (Morocco) Strike Fanega	70.	pounds (U.S.)
do	31.751	kilogram
do	0.0318	metric ton
do	0.0350	ton short or net
do	0.0312	ton long or gross
Full Fanega	118.	pounds (U.S.)
do	53.524	kilogram
do	0.0535	metric ton
do	0.0590	ton short or net
do	0.0527	ton long or gross



Smooth, flexible, dependable power for your HEAVY drilling loads

. . . with these big, rugged LE ROI Drilling Engines

A drilling rig is no place for weaklings. It's work that quickly shows what men and machines are made of.

That's why it means something when you see Le Roi drilling engines on the job in the deeper fields.

It means that men who must "deliver or else" have come to depend on Le Roi power . . . that careful engineering based on long experience with oil-field conditions — use of the finest materials money can buy — rugged construction to exceptional precision standards — have proved their worth on one tough job after another.

It means that you too can rely on steady, trouble-free service, with low maintenance cost — flashing response to pull safely through the pinches — and fuel bills that are easy on your costs when you "add up" at the end of the job.

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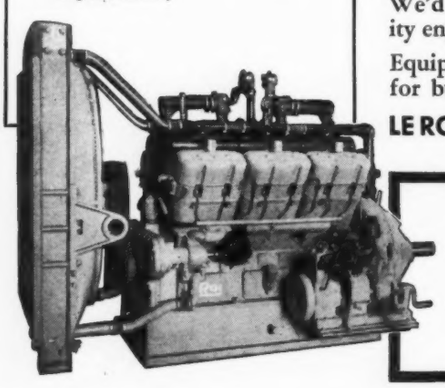
LE ROI COMPANY • MILWAUKEE, WISCONSIN • TULSA, OKLAHOMA
P-1

The V-12 Le Roi RX1SV

- 196-418 maximum H.P. — 157-334 H.P. load rating
- 60° V-type motor, 12 cylinders
- Overhead valves — for easy accessibility and fuel economy
- Gasoline, natural gas, or butane fuel
- Quick-acting, dependable gasoline starting engine
- Dual ignition — for extra dependability



General Machine & Supply Company
Wichita Falls — Odessa, Texas

Southern Engine & Pump Company
Houston — Dallas — Kilgore, Texas

Western Machinery Company
St. Louis, Missouri • Salem, Illinois

GRAVITY OF DRY OIL IN OIL-WATER MIXTURES, DEG. A.P.I.

Gravity of "wet" oil, deg. A.P.I.	Percent water in mixture									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
25.0	25.01	25.03	25.04	25.06	25.08	25.09	25.11	25.13	25.14	25.16
.1	.11	.13	.15	.16	.18	.20	.21	.23	.25	.26
.2	.22	.23	.25	.27	.28	.30	.32	.34	.35	.37
.3	.32	.34	.36	.37	.39	.41	.42	.44	.46	.48
.4	.43	.44	.46	.48	.49	.51	.53	.55	.56	.58
25.5	25.51	25.53	25.55	25.56	25.58	25.60	25.62	25.63	25.65	25.67
.6	.62	.63	.65	.67	.69	.70	.72	.74	.76	.78
.7	.72	.74	.76	.77	.79	.81	.83	.85	.86	.88
.8	.81	.83	.84	.86	.88	.90	.92	.94	.95	.97
.9	.91	.93	.95	.97	.99	**26.00**	26.02	26.04	26.06	26.08
26.0	26.02	26.04	26.06	26.07	26.09	26.11	26.13	26.15	26.16	26.18
.1	.13	.14	.16	.18	.20	.22	.23	.25	.27	.29
.2	.21	.23	.25	.27	.29	.30	.32	.34	.36	.38
.3	.32	.34	.36	.37	.39	.41	.43	.45	.47	.48
.4	.42	.44	.46	.48	.50	.52	.54	.55	.57	.59
26.5	26.51	26.53	26.55	26.57	26.59	26.61	26.62	26.64	26.66	26.68
.6	.62	.64	.66	.68	.69	.71	.73	.75	.77	.79
.7	.73	.74	.76	.78	.80	.82	.84	.86	.88	.90
.8	.81	.83	.85	.87	.89	.91	.93	.95	.97	.99
.9	.92	.94	.96	.98	**27.00**	27.02	27.04	27.05	27.07	27 09
27.0	27.03	27.05	27.07	27.08	27.10	27.12	27.14	27.16	27.18	27.20
.1	.12	.14	.15	.17	.19	.21	.23	.25	.27	.29
.2	.22	.24	.26	.28	.30	.32	.34	.36	.38	.40
.3	.31	.33	.35	.37	.39	.41	.43	.45	.47	.49
.4	.42	.44	.46	.48	.50	.52	.54	.56	.58	.60
27.5	27.53	27.55	27.57	27.59	27.61	27.63	27.65	27.67	27.69	27.71
.6	.62	.64	.66	.68	.70	.72	.74	.76	.78	.80
.7	.72	.74	.76	.78	.80	.82	.84	.86	.88	.90
.8	.81	.83	.85	.87	.89	.91	.93	.95	.98	**28.00**
.9	.92	.94	.96	.98	**28.00**	28.02	28.04	28.06	28.08	28.10
28.0	28.03	28.05	28.07	28.09	28.11	28.13	28.15	28.17	28.19	28.21
.1	.12	.14	.16	.18	.20	.22	.24	.26	.28	.30
.2	.23	.25	.27	.29	.31	.33	.35	.37	.39	.41
.3	.32	.34	.36	.38	.40	.42	.44	.46	.48	.51
.4	.43	.45	.47	.49	.51	.53	.55	.59	.61	.63
28.5	28.52	28.54	28.56	28.58	28.60	28.62	28.64	28.66	28.69	28.71
.6	.63	.65	.67	.69	.71	.73	.83	.77	.80	.82
.7	.72	.74	.76	.78	.80	.82	.84	.87	.88	.91
.8	.82	.85	.87	.89	.91	.93	.95	.98	**29.00**	.02
.9	.92	.94	.96	.98	**29.00**	29.02	29.05	29.07	29.09	29.11
29.0	29.02	29.05	29.07	29.09	29.11	29.13	29.16	29.18	28.20	29.22
.1	.12	.14	.16	.18	.20	.23	.25	.27	.29	.31
.2	.23	.25	.27	.29	.31	.34	.36	.38	.40	.42
.3	.32	.34	.36	.38	.41	.43	.45	.47	.49	.52
.4	.43	.45	.47	.49	.52	.54	.56	.58	.61	.63
29.5	29.52	29.54	29.56	29.59	29.61	29.63	29.65	29.68	29.70	29.72
.6	.63	.65	.67	.70	.72	.74	.76	.79	.81	.83
.7	.72	.74	.76	.79	.81	.83	.86	.88	.90	.93
.8	.83	.85	.87	.89	.92	.95	.97	.99	30.01	.04
.9	.92	.95	.97	.99	30.01	30.04	30.06	30.08	30.11	30.13

Gravity of dry oil in oil-water mixture, deg. A.P.I. with percent water in mixture less than one suggested by R. W. Miller, Phillips Petroleum Company, Oklahoma City, Oklahoma.

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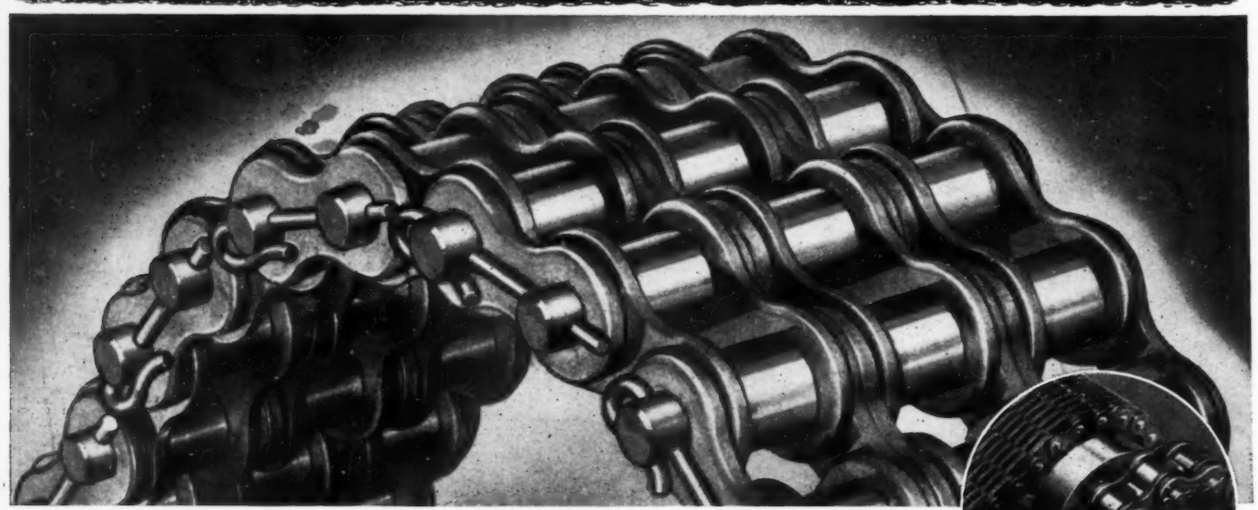
"NEW HORIZONS"

IN PERFORMANCE VALUE FOR EVERY DRIVE-UNIT



WHITNEY ROLLER CHAINS are "tested producers" . . . in their inbuilt ability to deliver full power, *around the clock*, to pumping units, rotaries, draw works and winches. For that's what they're doing now . . . in oil fields all over the world . . . at lowest cost per drive-unit.

All Whitney Chains are outstanding in performance because they're made with alloy-armored steels, to take in their stride far tougher conditions than they are normally called on to meet. And that's why it pays to specify "Whitney" for all power drives on new equipment, and for replacements on present equipment. Remember: Whitney Chains are built to take . . . *and keep* . . . a load off your mind. And prompt Whitney service is no farther away than the nearest distributor listed below. *Get in touch today.*

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Roller Chain & Sprockets, Silent Chain & Sprockets, Conveyor Chain & Sprockets, Roller Chain Flexible Couplings, Automatic Load Limiting Sprockets, Automatic Drive Tensioners, Woodruff Type Machine Keys and Cutters.

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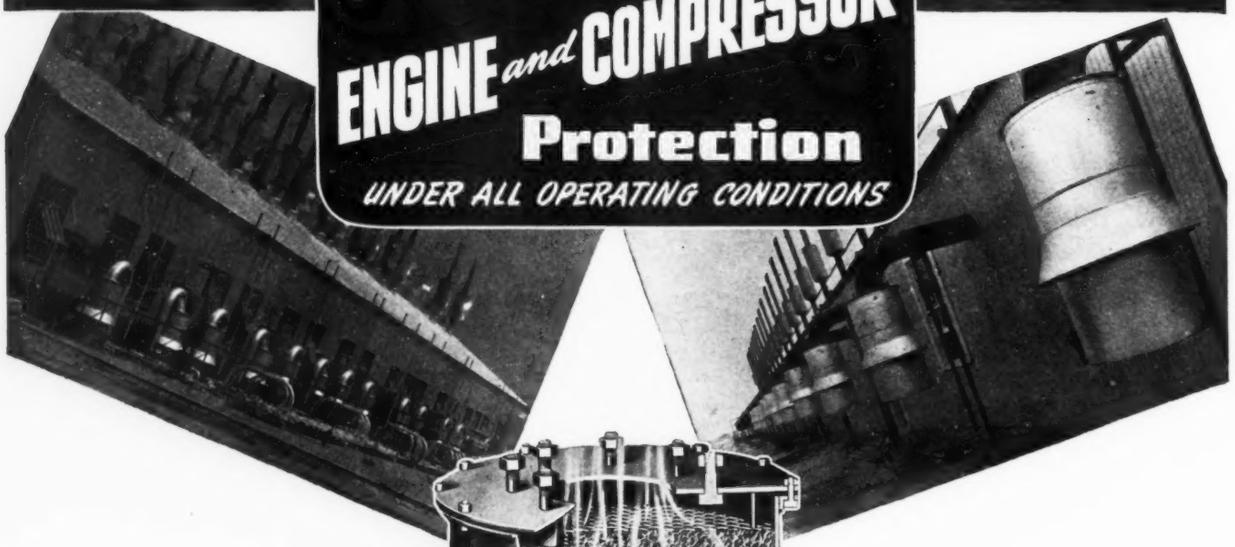
California

CONVERSION TABLES—FOREIGN VOLUME UNITS

Multiply the quantity of:	By	to obtain the quantity of:
Acre—feet	325851.	gallons (U.S.)
do	7758.357	Petroleum barrels (U.S.)
do	43560.	cubic feet
do	1613.3333	cubic yards
Almudes (Portugal)	4.425	gallons (U.S.)
do	0.1054	petroleum barrels (U.S.)
do	16.751	liters
do	1022.2	cubic inches
do	0.5915	cubic feet
do	0.0219	cubic yards
arrobas (liquid)(Cuba)	4.263	gallons (U.S.)
do	0.1015	petroleum barrels (U.S.)
do	16.137	liters
do	984.75	cubic inches
do	0.5699	cubic feet
do	0.0211	cubic yards
barrels (petroleum)(U.S.)	42.	gallons (U.S.)
do	158.9881	liters
do	9702.	cubic inches
do	5.61460	cubic feet
do	0.20794	cubic yards
barrels (petroleum)(Canada)	42.0112	gallons (U.S.)
do	1.00269	petroleum barrels (U.S.)
do	159.0307	liters
do	9704.	cubic inches
do	5.61608	cubic feet
do	0.20800	cubic yards
barrels (Malta—customs)	11.4	gallons (U.S.)
do	0.2714	petroleum barrels (U.S.)
do	43.154	liters
do	2633.4	cubic inches
do	1.5239	cubic feet
do	0.0564	cubic yards
barils (Argentine Rep. and Mexico)	20.089	gallons (U.S.)
do	0.4783	petroleum barrels (U.S.)
do	76.046	liters
do	4640.6	cubic inches
do	2.6855	cubic feet
do	0.0994	cubic yards
Centaros (Central America)	4.2631	gallons (U.S.)
do	0.10151	petroleum barrels (U.S.)
do	16.138	liters
do	984.78	cubic inches
do	0.5699	cubic feet
do	0.02111	cubic yards
cubic feet	7.4805	gallons (U.S.)
do	0.1781	petroleum barrels (U.S.)
do	28.317	liters
cubic yards	168.184	gallons (U.S.)
do	4.8089	petroleum barrels (U.S.)
do	764.559	liters
fanega (liquid)(Spain)	16.	gallons (U.S.)
do	0.3809	petroleum barrels (U.S.)
do	60.5669	liters
do	3696.	cubic inches
do	2.1389	cubic feet
do	0.0792	cubic yards
gallons (U.S.)	0.0238	petroleum barrels (U.S.)
do	3.7854	liters
do	231.	cubic inches
do	0.1337	cubic feet
do	0.00495	cubic yards
gallons (Imperial-British)	1.2009	gallons (U.S.)
do	0.0286	petroleum barrels (U.S.)
do	4.546	liters
do	277.41	cubic inches
do	0.1605	cubic feet
do	0.00594	cubic yards
Pood (Russia)	4.3290	gallons (U.S.
do	0.1031	Petroleum barrels (U.S.)
do	16.387	liters
do	1000.	cubic inches
do	.5787	cubic feet
do	.0214	cubic yards

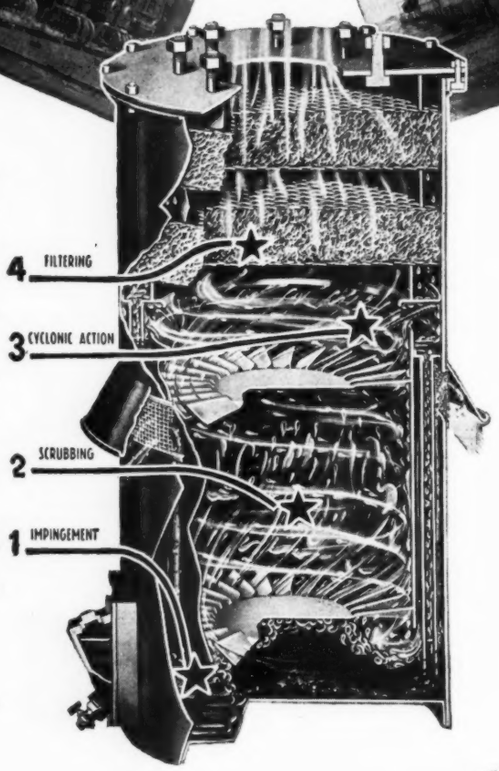
Positive ENGINE and COMPRESSOR Protection

UNDER ALL OPERATING CONDITIONS



The demands being made on engine performance today make it necessary to protect those engines from the abrasive action or air borne dust and grit. Cycoil air cleaners assure positive elimination of dust from engine intake air. Engine manufacturers know the Cycoil and its exclusive advantages. They will be glad to equip your new engines with Cycoil cleaners. Remember, you pay only a little more for the best!

SEND FOR FREE ENGINEERING DATA



Whether your problem is one of cleaning air for gas engines, Diesel engines, or compressors; or cleaning gas in recycling operations, or in a polymerization process—Cycoil cleaners offer the most efficient and positive solution. AAF engineers, with a background of twenty-two years experience in air and gas cleaning, are available without obligation for consultation on your cleaning problems. Write for descriptive literature. American Air Filter Company, Inc., 383 Central Avenue, Louisville, Kentucky.

BULLETINS SENT ON REQUEST

AMERICAN *Cycoil* AIR and GAS CLEANERS

WEIGHT OF DRY MATERIAL ADDED TO DRILLING MUD, LB. PER GAL. (SP. GR. OF ADDITIVE 2.50)

Original fluid, mud or water		Desired mud weight, lb. per gal.																				
Weight, lb. per gal.	Specific Gravity	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
		1.08	1.14	1.20	1.26	1.32	1.38	1.44	1.50	1.56	1.62	1.68	1.74	1.80	1.86	1.92	1.98	2.04	2.10	2.16	2.22	2.28	2.34
*8.345	1.00	1.18	2.14	3.20	4.37	5.65	7.08	8.65	10.4	12.4	14.7	17.3	20.3	23.8	28.0	33.1	39.3	47.2	57.4	71.2	90.9	121.3	174.7
9.0	1.08		0.93	1.93	3.03	4.24	5.59	7.08	8.76	10.7	12.8	15.3	18.1	21.4	25.4	30.2	36.1	43.5	53.2	66.2	84.9	113.8	164.2
9.5	1.14			0.96	2.02	3.18	4.47	5.90	7.51	9.35	11.3	13.8	16.4	19.7	23.4	28.0	33.7	40.7	50.1	62.6	80.4	108.1	156.5
10.0	1.20				1.01	2.12	3.35	4.72	6.26	8.14	9.93	12.2	14.9	17.9	21.5	25.9	31.3	38.1	47.0	58.9	76.0	102.4	148.6
10.5	1.26					1.06	2.24	3.55	5.01	6.67	8.51	10.7	13.2	16.1	19.5	23.7	28.9	35.4	43.8	55.2	71.5	96.7	140.9
11.0	1.32						1.11	2.36	3.76	5.32	7.11	9.18	11.5	14.3	17.6	21.6	26.5	32.6	40.7	51.6	67.1	91.0	133.0
11.5	1.38							1.18	2.50	4.00	5.69	7.64	9.85	12.5	15.7	19.4	24.0	30.0	37.6	47.9	62.6	85.3	125.2
12.0	1.44								1.25	2.66	4.26	6.11	8.24	10.8	13.7	17.3	21.7	27.2	34.5	44.1	58.1	79.7	117.7
12.5	1.50									1.34	2.85	4.58	6.58	8.93	11.8	15.1	19.3	24.5	31.3	40.5	53.7	73.7	109.3
13.0	1.56										1.42	3.05	4.94	7.15	9.76	12.9	16.9	21.8	28.2	36.8	49.2	68.3	101.7
13.5	1.62											1.55	3.30	5.37	7.83	10.8	14.4	19.0	25.0	33.1	44.7	62.6	94.3
14.0	1.68												1.64	3.58	5.87	8.60	12.0	16.4	21.9	29.5	40.2	56.9	86.0
14.5	1.74													1.79	3.91	6.48	7.22	13.6	18.8	25.8	35.8	51.2	78.3
15.0	1.80														1.95	4.31	7.22	10.8	15.7	22.1	31.3	45.5	70.4
15.5	1.86															2.16	4.82	8.24	12.5	18.4	26.8	31.5	62.6
16.0	1.92																2.40	5.44	9.43	14.7	22.4	34.1	54.7
16.5	1.98																	2.72	6.26	11.0	17.9	28.5	47.0
17.0	2.04																		3.13	7.36	13.4	22.8	39.1
17.5	2.10																			3.68	8.93	17.1	31.3
18.0	2.16																				4.47	11.3	23.4
18.5	2.22																					5.69	15.7
19.0	2.28																						7.83

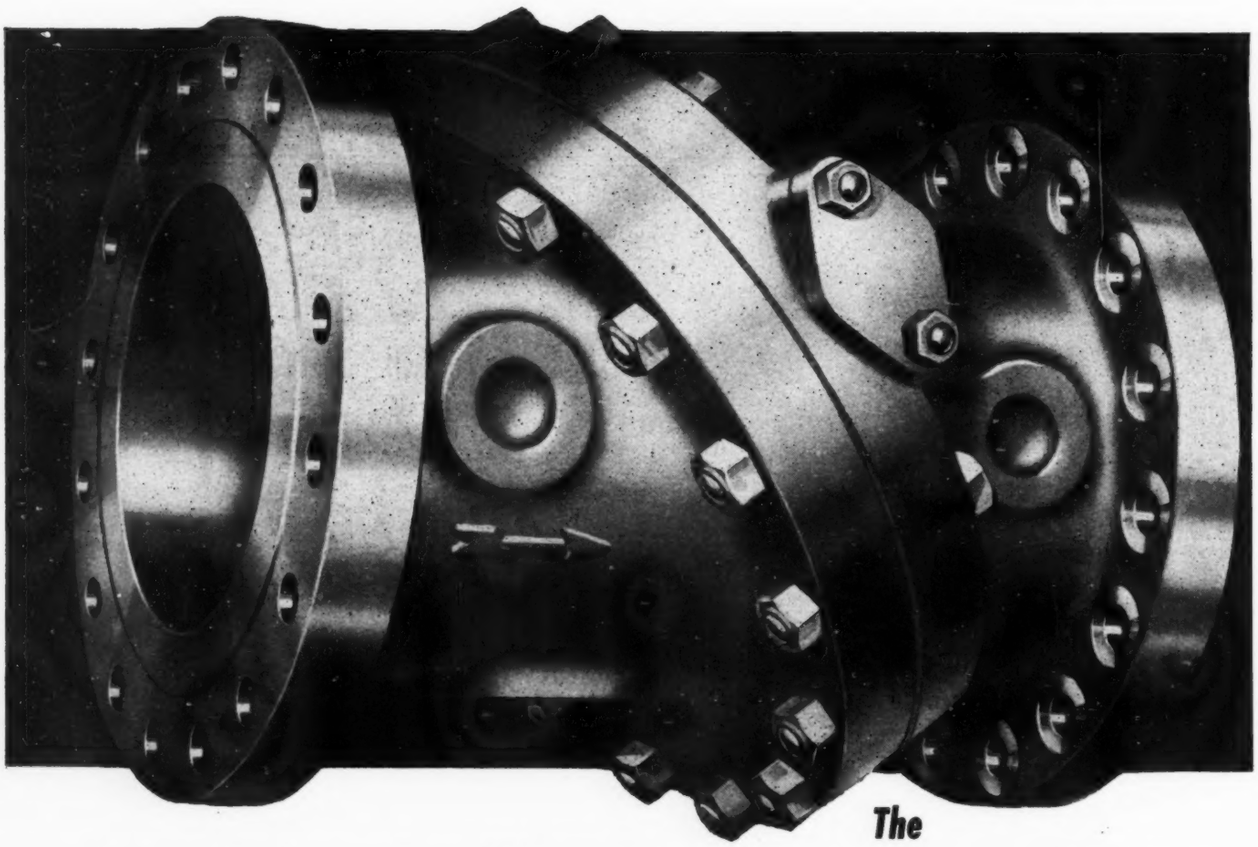
Note: The body of this table supplies the weight in lb. of the dry solid to be added per gal. to a drilling fluid of known weight to obtain a mud of higher weight. The above table was calculated with an additive of specific gravity 2.50 (average sp. gr. of clay, feldspar, and borates).

To use table find weight of original mud in left hand col. and desired mud weight in top line. Multiply figure from body of table by the vol. of mud in gal. in well or mud pit or times total amount of mud desired when mixing with water.

*Water.

PIPE DOWN!

on Valve-Slam, Line-Vibration, Hammering & Surging ...Put in CHAPMAN STEEL NON-SLAM Check Valves



You save trouble and money *on the quiet* with Chapman Non-Slam Check Valves. For no matter how often they open and close, they never flutter or slam. No leakage, no opened pipe-joints, no bottle-necking of pipeline capacity. Friction losses are cut 65 to 80%.

Silence is unbroken because wear has been excluded by a single moving part . . . a balanced disc that is cushioned quietly to a drop-tight seat. *Maintenance crews never hear from it.*

Chapman Steel Non-Slam Check Valves sharply point up operating efficiency in refinery service and on natural gas lines. Made for pressures from 150 to 1500 lb., with any type of end-connection, and in a wide range of steels.

The

CHAPMAN

VALVE MANUFACTURING CO.

Indian Orchard, Mass.

Static Press.
1100-1195 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in. ga.																			
	1100	1105	1110	1115	1120	1125	1130	1135	1140	1145	1150	1155	1160	1165	1170	1175	1180	1185	1190	1195
2	47.21	47.31	47.43	47.52	47.64	47.74	47.85	47.95	48.05	48.16	48.26	48.36	48.47	48.57	48.67	48.78	48.88	48.98	49.08	49.19
4	66.78	66.92	67.08	67.22	67.38	67.52	67.68	67.82	67.96	68.12	68.26	68.40	68.56	68.70	68.84	69.00	69.14	69.28	69.42	69.58
6	81.77	81.94	82.14	82.31	82.51	82.68	82.87	83.04	83.22	83.41	83.58	83.76	83.95	84.12	84.29	84.49	84.66	84.83	85.80	85.20
8	94.43	94.62	94.85	95.05	95.27	95.47	95.70	95.90	96.10	96.32	96.52	96.72	96.94	97.14	97.34	97.57	97.76	97.96	98.16	98.39
10	105.6	105.8	106.1	106.3	106.5	106.7	107.0	107.2	107.4	107.7	107.9	108.1	108.4	108.6	108.8	109.1	109.3	109.5	109.8	110.0
12	115.7	115.9	116.2	116.4	116.7	116.9	117.2	117.5	117.7	118.0	118.2	118.5	118.7	119.0	119.2	119.5	119.8	120.0	120.2	120.5
14	124.9	125.2	125.5	125.8	126.1	126.3	126.6	126.9	127.1	127.4	127.7	128.0	128.3	128.5	128.8	129.9	129.4	129.6	129.9	130.2
16	133.6	133.8	134.2	134.4	134.8	135.0	135.4	135.6	135.9	136.2	136.5	136.8	137.1	137.4	137.7	138.0	138.3	138.6	138.8	139.2
18	141.7	142.0	142.3	142.6	142.9	143.2	143.6	143.9	144.2	144.5	144.8	145.1	145.4	145.7	146.0	146.4	146.7	147.0	147.3	147.6
20	149.3	149.6	150.0	150.3	150.7	151.0	151.3	151.6	151.9	152.3	152.6	152.9	153.3	153.6	153.9	154.3	154.6	154.9	155.2	155.6
21	153.0	153.3	153.7	154.0	154.4	154.7	155.1	155.4	155.7	156.1	156.4	156.6	157.0	157.3	157.7	158.0	158.3	158.7	159.0	159.4
22	156.6	156.9	157.3	157.6	158.0	158.3	158.7	159.0	159.4	159.7	160.1	160.4	160.8	161.1	161.4	161.8	162.1	162.5	162.8	163.2
23	160.1	160.5	160.9	161.2	161.6	161.9	162.3	162.6	163.0	163.4	163.7	164.0	164.4	164.7	165.1	165.5	165.8	166.1	166.5	166.9
24	163.6	163.9	164.3	164.7	165.0	165.4	165.8	166.1	166.5	166.9	167.2	167.5	167.9	168.3	168.6	169.0	169.4	169.7	170.0	170.4
25	167.0	167.3	167.7	168.0	168.5	168.8	169.2	169.6	169.9	170.3	170.6	171.0	171.4	171.7	172.1	172.5	172.8	173.2	173.6	174.0
26	170.3	170.6	171.0	171.4	171.8	172.1	172.6	172.9	173.3	173.7	174.0	174.4	174.8	175.2	175.5	175.9	176.3	176.6	177.0	177.4
27	173.5	173.9	174.3	174.6	175.1	175.4	175.8	176.2	176.6	177.0	177.3	177.7	178.1	178.5	178.8	179.3	179.6	180.0	180.4	180.8
28	176.7	177.1	177.5	177.9	178.3	178.7	179.1	179.5	179.8	180.2	180.6	181.0	181.4	181.8	182.2	182.6	182.9	183.3	183.7	184.1
29	179.8	180.2	180.6	181.0	181.4	181.8	182.2	182.6	183.0	183.4	183.8	184.2	184.6	185.0	185.4	185.8	186.2	186.5	186.9	187.3
30	182.9	183.3	183.7	184.1	184.5	184.9	185.3	184.7	186.1	186.5	186.9	187.3	187.8	188.1	188.5	189.0	189.3	189.7	190.1	190.5
31	195.9	186.3	186.7	187.1	187.6	188.0	188.4	188.8	189.2	189.6	190.0	190.4	190.9	191.3	191.6	192.1	192.5	192.9	193.3	193.7
32	198.9	189.3	189.7	190.1	190.6	191.0	191.4	191.8	192.2	192.7	193.1	193.5	193.9	194.3	194.7	195.2	195.6	196.0	196.4	196.8
33	191 8	192.2	192.7	193.1	193.5	193.9	194.4	194.8	195.2	195.7	196.1	196.5	196.9	197.3	197.7	198.2	198.6	199.0	199.4	199.9
34	194.7	195.1	195.6	196.0	196.4	196.9	197.3	197.7	198.1	198.6	199.0	199.4	199.9	200.3	200.7	201.2	201.6	202.0	202.4	202.9
35	197.5	197.9	198.4	198.8	199.8	199.7	200.2	200.6	201.0	201.5	201.9	202.3	202.8	203.2	203.6	204.1	204.5	204.9	205.3	205.8
36	200.3	200.8	201.2	201.7	202.1	202.6	203.0	203.5	203.9	204.4	204.8	205.2	205.7	206.1	206.5	207.0	207.4	207.8	208.3	208.7
37	203.1	203.5	204.0	204.4	204.9	205.4	205.8	206.3	206.7	207.2	207.6	208.0	208.5	208.9	209.4	209.9	210.3	210.7	211.1	211.6
38	205.8	206.2	206.7	207.2	207.7	208.1	208.6	209.0	209.5	209.9	210.4	210.8	211.3	211.7	212.2	212.6	213.1	213.5	213.9	214.4
39	208.5	209.0	209.5	209.9	210.4	210.8	211.3	211.8	212.2	212.7	213.1	213.6	214.1	214.5	214.9	215.4	215.9	216.3	216.8	217.3
40	211.2	211.6	212.1	212.6	213.1	213.5	214.0	214.5	214.9	215.4	215.9	216.3	216.8	217.3	217.7	218.2	218.7	219.1	219.5	220.0
41	213.8	214.2	214.7	215.2	215.7	216.2	216.7	217.1	217.6	218.1	218.5	219.0	219.5	219.9	220.4	220.9	221.4	221.8	222.2	222.8
42	216.4	216.9	217.4	217.8	218.3	218.8	219.3	219.8	220.2	220.7	221.2	221.7	222.2	222.6	223.1	223.6	224.0	224.5	225.0	225.5
43	218.9	219.4	219.9	220.4	220.9	221.4	221.9	222.3	222.8	223.3	223.8	224.2	224.8	225.2	225.7	226.2	226.7	227.1	227.6	228.1
44	221.5	221.9	222.5	222.9	223.5	223.9	224.5	224.9	225.4	225.9	226.4	226.8	227.4	227.8	228.3	228.8	229.3	229.8	230.2	230.8
45	224.0	224.4	225.0	225.5	226.0	226.5	227.0	227.5	227.9	228.5	228.9	229.4	230.0	230.4	230.9	231.4	231.9	232.4	232.8	233.4
46	226.5	226.9	227.5	227.9	228.5	229.0	229.5	230.0	230.5	231.0	231.5	231.9	232.5	233.0	233.4	234.0	234.5	234.9	235.4	235.9
47	228.9	229.4	230.0	230.4	231.0	231.5	232.0	232.5	233.0	233.5	234.0	234.5	235.0	235.5	236.0	236.5	237.0	237.5	238.0	238.5
48	231.3	231.8	232.4	232.9	233.4	233.9	234.4	234.9	235.4	236.0	236.5	236.9	237.5	238.0	238.5	239.0	239.5	240.0	240.5	241.0
49	233.7	234.2	234.8	235.3	235.8	236.2	236.9	237.4	237.9	238.4	238.9	239.4	240.0	240.5	240.9	241.5	242.0	242.5	243.0	243.5
50	236.1	236.6	237.2	237.7	238.2	238.7	239.3	239.8	240.3	240.8	241.3	241.8	242.4	242.9	243.4	243.9	244.4	244.9	245.4	246.0
51	238.4	238.9	239.5	240.0	240.6	241.1	241.7	242.2	242.7	243.2	243.7	244.2	244.8	245.3	245.8	246.4	246.9	247.4	247.9	248.4
52	240.8	241.3	241.9	242.4	242.9	243.4	244.0	244.5	245.0	245.6	246.1	246.6	247.2	247.7	248.2	248.8	249.3	249.8	250.3	250.9
53	243.1	243.6	244.2	244.7	245.3	245.8	246.4	246.9	247.4	248.0	248.5	249.0	249.6	250.1	250.6	251.2	251.7	252.2	252.7	253.3
54	245.3	245.9	246.5	247.0	247.6	248.1	248.7	249.2	249.7	250.3	250.8	251.3	251.9	252.4	252.9	253.5	254.0	254.5	255.0	255.6
55	247.6	248.1	248.7	249.3	249.8	250.4	251.0	251.5	252.0	252.6	253.1	253.6	254.2	254.7	255.3	255.9	256.4	256.9	257.4	258.0
56	249.9	250.4	251.0	251.5	252.1	252.6	253.2	253.7	254.3	254.8	255.4	255.9	256.5	257.0	257.6	258.2	258.7	259.2	259.7	260.3
57	252.1	252.6	253.2	253.8	254.4	254.9	255.5	256.0	256.5	257.2	257.7	258.2	258.8	259.3	259.9	260.5	261.0	261.5	262.1	262.7
58	254.3	254.8	255.4	256.0	256.6	257.1	257.7	258.3	258.8	259.4	259.9	260.5	261.1	261.6	262.1	262.7	263.3	263.8	264.4	265.0
59	256.5	257.0	257.6	258.2	258.8	259.4	260.0	260.5	261.0	261.6	262.2	262.7	263.3	263.8	264.4	265.0	265.5	266.1	266.6	267.2
60	258.6	259.2	259.8	260.3	260.9	261.5	262.1	262.7	263.2	263.8	264.4	264.9	265.5	266.1	266.6	267.2	267.8	268.3	268.9	269.5
61	260.8	261.3	261.9	262.5	263.1	263.7	264.3	264.8	265.4	266.0	266.6	267.1	267.7	268.3	268.8	269.4	270.0	270.5	271.1	271.7
62	262.9	263.5	264.1	264.6	265.3	265.8	266.5	267.0	267.6	268.2	268.7	269.3	270.0	270.5	271.0	271.7	272.2	272.8	273.3	273.9
63	265.0	265.6	266.2	266.8	267.4	268.0	268.6	269.1	269.7	270.3	270.9	271.4	272.1	272.6	273.2	273.8	274.4	274.9	275.5	276.1
64	267.1	267.7	268.3	268.9	269.5	270.1	270.7	271.3	271.8	272.5	273.0	273.6	274.2	274.8	275.4	276.0	276.6	277.1	277.7	278.3
65	269.2	269.8	270.4	271.0	271.6	272.2	272.8	273.4	273.9	274.6	275.2	275.7	276.4	276.9	277.5	278.1	278.7	279.3	279.8	280.5
66	271.3	271.8	272.5	273.0	273.7	274.3	274.9	275.5	276.1	276.7	277.3	277.8	278.5	279.1	279.6	280.3	280.8	281.4	282.0	282.6
67	273.3	273.9	274.5	275.1	275.8	276.3	277.0	277.6	278.1	278.8	279.4	279.9	280.6	281.2	281.7	282.4	283.0	283.5	284.1	284.8
68	275.3	275.9	276.6	277.1	277.8	278.4	279.0	279.6	280.2	280.9	281.4	282.0	282.7	283.3	283.8	284.5	285.1	285.6	286.2	286.9
69	277.4	278.0	278.6	279.2	279.9	280.4	281.1	281.7	282.3	282.9	283.5	284.1	284.8	285.3	285.9	286.6	287.2	287.8	288.3	289.0
70	279.4	280.0	280.6	281.2	281.9	282.5	283.1	283.7	284.3	285.0	285.6	286.2	286.8	287.4	288.0	288.7	289.2	289.8	290.4	291.1
71	281.3	281.9	282.6	283.2	283.9	284.5	285.1	285.7	286.3	287.0	287.6	288.2	288.8	289.4	290.0	290.7	291.3	291.9	292.5	293.1
72	283.3	283.9	284.6	285.2	285.9	286.5	287.1	287.7	288.3	289.0	289.6	290.2	290.9	291.5	292.1	292.7	293.3	293.9	294.5	295.2
73	285.3	285.9	286.6	287.2	287.8	288.4	289.1	289.7	290.3	291.0	291.6	292.2	292.9	293.5	294.1	294.8	295.4	296.0	296.6	297.2
74	287.2	287.8	288.5	289.1	289.8	290.4	291.1	291.7	292.3	293.0	293.6	294.2	294.9	295.5	296.1	296.8	297.4	298.0	298.6	299.3
75	289.2	289.8	290.5	291.1	291.8	292.4	293.1	293.7	294.3	295.0	295.6	296.2	296.9	297.5	298.1	298.8	299.4	300.0	300.6	301.3
76	291.1	291.7	292.4	293.0	293.7	294.3	295.0	295.6	296.2	296.9	297.5	298.2	298.9	299.5	300.1	300.8	301.4	302.0	302.6	303.3
77	293.0	293.6	294.3	294.9	295.6	296.2	296.9	297.6	298.2	298.9	299.5	300.1	300.8	301.4	302.0	302.7	303.4	304.0	304.6	305.3
78	294.9	295.5	296.2	296.8	297.6	298.2	298.9	299.5	300.1	300.8	301.4	302.0	302.7	303.4	304.0	304.7	305.3	305.9	306.6	307.3
79	296.8	297.4	298.1	298.7	299.4	300.1	300.8	301.4	302.0	302.7	303.3	304.0	304.7	305.3	305.9	306.6	307.3	307.9	308.5	309.2
80	298.6	299.3	300.0	300.6	301.3	301.9	302.7	303.3	303.9	304.6	305.3	305.9	306.6	307.2	307.9	308.6	309.2	309.8	310.4	311.2
82	302.3	303.0	303.7	304.3	305.1	305.7	306.4	307.1	307.7	308.4	309.0	309.7	310.4	311.0	311.7	312.4	313.0	313.7	314.3	315.0
84	306.0	306.7	307.4	308.0	308.8	309.4	310.1	310.8	311.4	312.2	312.8	313.4	314.2	314.8	315.5	316.2	316.8	317.5	318.1	318.9
86	309.7	310.3	311.0	311.7	312.4	313.1	313.8	314.5	315.1	315.9	316.5	317.2	317.9	318.6	319.2	320.0	320.6	321.3	321.9	322.6
88	313.2	313.9	314.6	315.3	316.0	316.7	317.4	318.1	318.8	319.5	320.2	320.8	321.6	322.2	322.9	323.6	324.3	325.0	325.6	326.4
90	316.8	317.4	318.2	318.9	319.6	320.3	321.0	321.7	322.4	323.1	323.8	324.5	325.2	325.9	326.5	327.3	328.0	328.6	329.3	330.0
92	320.3	320.9	321.7	322.4	323.2	323.8	324.6	325.3	325.9	326.7	327.4	328.0	328.8	329.5	330.2	330.9	331.6	332.3	332.9	333.7
94	323.7	323.4	325.2	325.8	326.6	327.3	328.1	328.8	329.4	330.2	330.9	331.6	332.3	333.0	333.7	334.5	335.2	335.8	336.5	337.3
96	327.2	327.8	328.6	329.3	330.1	330.8	331.6	332.3	332.9	333.7	334.4	335.1	335.9	336.6	337.3	338.0	338.7	339.4	340.1	340.9
98	330.5	331.2	332.0	332.7	333.5	334.2	335.0	335.7	336.4	337.2	337.9	338.5	339.3	340.0	340.7	341.5	342.2	342.9	343.6	344.4
100	333.9	334.6	335.4	336.1	336.9	337.6	338.4	339.1	339.8	340.6	341.3	342.0	342.8	343.5	344.2	345.0	345.7	346.4	347.1	347.9

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in. abs., and in. of water respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

FOR COMPLETE DUST PROTECTION

FRANCITAS *Gas Company*

selects

VORTOX AIR CLEANERS

For:

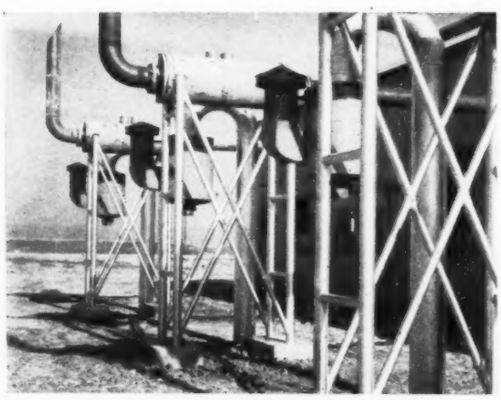
SIMPLICITY
DEPENDABILITY
EFFICIENCY

VORTOX SIMPLICITY OF DESIGN
construction and operation insures best and cheapest maintenance.

VORTOX DEPENDABILITY
provides protection under most severe dust loads or adverse operating conditions.

VORTOX EFFICIENCY
gives maximum protection against damage to all internal parts of any engine or compressor regardless of size or service required.

VORTOX MANUFACTURING COMPANY
Claremont, California



Vortox Air Cleaners protecting three 600 horsepower compressor engines of Francitas Gas Company.

VORTOX

OIL TYPE SELF-WASHING
AIR CLEANER

RISE IN FLUID LEVEL, ETC., DUE TO RUNNING 4-IN. EXTERNAL-UPSET TUBING IN WELL FLUID

Diameter of outer string or open hole, in.	Internal diameter of outer string or open hole, in.	Volume[1] contained in outer string or open hole		Volume[1] contained in annular space		Volume[1] in well bore when tubing is in hole (volume in annulus plus volume in tubing)		For every 100 ft. of tubing run in fluid, fluid level will be raised:	
		bbl.	gal.	gal.	bbl.	gal.	bbl.	in annular space when lower end of tubing is closed, ft.-in.	in well bore when lower end of tubing is open, ft.-in.
Casing strings[2]									
6⅝	6.135	153.6	3.657	69.8	1.662	133.7	3.184	120- 0	12- 7
6⅝	5.675	131.4	3.129	47.6	1.133	111.5	2.655	176- 0	15- 1
7	6.538	174.4	4.152	90.6	2.157	154.5	3.679	92- 5	10-11
7	5.920	143.0	3.405	59.2	1.409	123.1	2.931	141- 6	13- 8
7⅝	7.125	207.1	4.931	123.3	2.935	187.2	4.458	67-11	9- 0
7⅝	6.625	179.1	4.624	95.3	2.269	159.2	3.791	87-10	10- 7
8⅝	8.097	267.5	6.369	183.7	4.373	246.6	5.872	45- 7	6- 8
8⅝	7.511	230.2	5.481	146.4	3.485	210.3	5.008	57- 3	8- 0
9⅝	9.063	335.1	7.979	251.3	5.983	315.2	7.505	33- 4	5- 4
9⅝	8.535	297.2	7.076	213.4	5.081	277.3	6.603	39- 3	6- 1
10¾	10.192	423.8	10.090	340.0	8.095	403.9	9.617	23-10	4- 2
10¾	9.760	388.7	9.255	304.9	7.259	368.8	8.781	26- 8	4- 7
11¾	11.150	507.2	12.076	423.4	10.081	487.3	11.603	19- 9	3- 5
11¾	10.772	473.4	11.271	389.6	9.276	453.5	10.798	21- 6	3- 8
13⅜	12.715	659.6	15.705	575.8	13.709	639.7	15.231	14- 7	2- 8
13⅜	12.347	622.0	14.810	538.2	12.814	602.1	14.336	15- 7	2-10
Open hole (bit size)[3]									
5⅝	5.675	131.4	3.129	47.6	1.133	111.5	2.655	176- 0	15- 1
6	6.000	146.9	3.498	63.1	1.502	127.0	3.024	132- 8	16- 3
6⅛	6.125	153.1	3.645	69.3	1.650	133.2	3.172	120-10	12- 7
6½	6.500	172.4	4.105	88.6	2.109	152.5	3.631	94- 6	11- 0
6¾	6.750	185.9	4.426	102.1	2.431	166.0	3.953	82- 0	10- 2
7	7.000	199.9	4.760	116.1	2.764	180.0	4.286	72- 2	9- 4
7½[4]	7.500	229.5	5.464	145.7	3.469	209.6	4.991	57- 6	8- 0
7¾[4]	7.750	245.1	5.836	161.3	3.840	225.2	5.362	51-11	7- 6
8¼[4]	8.500	294.8	7.019	211.0	5.024	274.9	6.456	39- 8	6- 1
9¾[4]	9.750	387.9	9.236	304.1	7.240	368.0	8.762	26- 9	4- 7
10⅝	10.625	460.6	10.967	376.8	8.971	440.7	10.493	22- 3	3-10

The 4-in. external-upset tubing has a calculated weight of 12.91 lb. per ft. (including a coupling spaced every 20 ft.). The volume displaced by 100 ft. of tubing and 5 couplings: (1) by the steel itself (with lower end of tubing open), 16.81 gal. or 0.40021 bbl.; (2) by the pipe (with lower end of tubing closed), 83.757 gal. or 1.9942 bbl. The volume conttained within 100 ft. of the tubing is 63.917 gal. or 1.5218 bbl.

[1]All volume figures are based on 100 ft. of depth; multiply to convert to other depths or lengths. For example, if the depth or length is 5196 ft., multiply by 51.96.

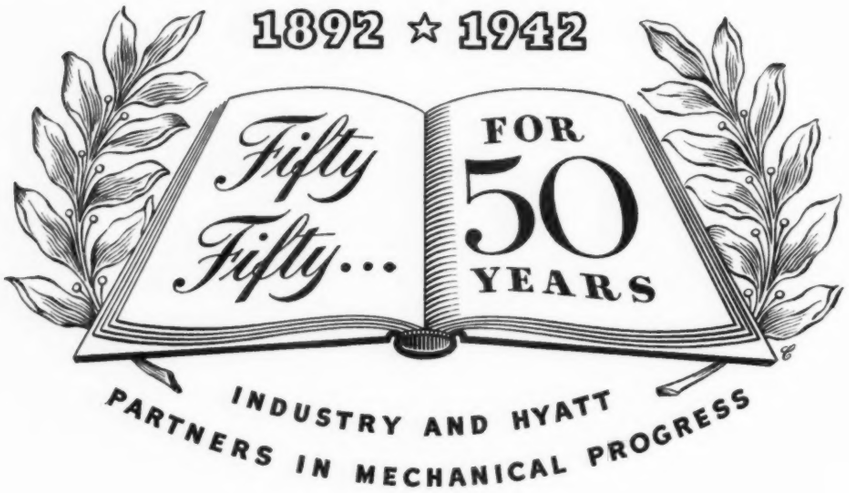
[2]Only maximum and minimum weights of pipe are shown for each casing size.

[3]Variation in diameter of open hole due to caving, etc., is disregarded.

[4]This diameter is an average of the two bit sizes ⅛ in. larger and smaller, respectively.

Table suggested by George B. Rice, Butler & Horne Drilling Co., Dallas, Texas.

THANKS, INDUSTRY!



WE'VE COME A LONG WAY TOGETHER during the past fifty years. We've helped America through emergencies . . . and through the greatest industrial era in her history. We've brought the advantages of anti-friction roller bearings to the many new and perplexing mechanisms of industrial pioneers. The accomplishments have been great, the rewards rich . . . for Industry, for Hyatt, for America!

Inventive genius and engineering talent have guided us through the years . . . the experiences of one have helped and improved the other. Many design problems have been solved. Many application handicaps have been overcome. We've shown each other many new, better ways of doing things.

Today, on our 50th Anniversary, we feel gratified that you are placing Hyatts in machinery and equipment of all kinds...in factory and field, on highway and railway, in war and peace-time assignments . . . that you are calling upon Hyatt and Hyatt Roller Bearings, more than ever before, to help in upholding the excellence of your regular products and the products you are building for Victory.

For this confidence, again we say . . . THANKS, INDUSTRY. Hyatt aims to keep pace with you into the future—America's future—building the very best that seasoned experience and fresh imagination can produce. So let's set our sights on tomorrow . . . let's keep going "Fifty-fifty for 50 years" . . . and more!

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Pittsburgh, Detroit and San Francisco.

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P 751.6
P 729.9

Shell Isomerization Process for the Production of Isobutane

☆ **Conversion of normal butane to *iso*butane by isomerization fills essential need in the manufacture of high octane gasoline**

by L. J. Coulthurst
Design Engineer, Foster Wheeler Corporation

Introduction

DURING the last six years a great series of advances has taken place in the technique of manufacturing aviation gasoline. Practically all of these advances consist of various catalytic processes for the production of *iso*paraffinic hydrocarbons of the multi-branch type. One of the most widely accepted of these various advances has been the catalytic sulphuric acid alkylation process, which is an effective and efficient method of producing quantities of high octane blending stock for use as the main ingredient for 100-octane aviation gasoline. Alkylation brings about a direct combination of butylenes (C_4H_8) or other olefines with *iso*butane (C_4H_{10}) to produce saturated *iso*paraffin hydrocarbons possessing a molecular weight and carbon content equal to the sum of the molecular weights and carbon contents of the *iso*butane and the olefine reactants. Commercial quantities of *iso*butane for use as alkylation feed stock are not readily accessible to all refiners, but an ample supply of normal butane is usually available as it is the most abundant of the 4-carbon-atom hydrocarbons found in petroleum. It is now commercially possible to convert practically all this normal butane to *iso*butane by the process of "isomerization" and thus provide for the alkylation of large quantities of butylenes that are available.

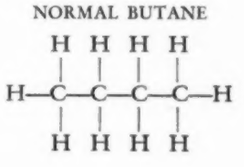
Chemists have long applied the term "isomerism" to a phenomenon characteristic of many organic compounds, including those occurring in petroleum, which have the same percentage composition and molecular weight, yet exhibit different physical properties. These compounds are called "isomers." These different physical properties are due to differences in the arrangement of the atoms in the molecule.

For example, there are two substances that have the composition and molecular weight represented by C_4H_{10} (four carbon atoms and ten hydrogen atoms combined to form one molecule). Two possible arrangements of the atoms in a molecule of this composition suggest themselves and they can be represented thus:

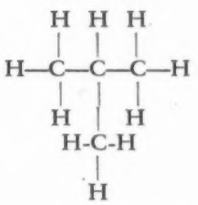
L. J. COULTHURST

is a native of San Diego, California—Upon graduating from High School he attended Leland Stanford University at Palo Alto and graduated in 1924, obtaining an A.B. degree in chemistry—His activity subsequently was of a broad character, giving him insight to many plants and processes—From 1924 to 1925 he was engaged in the Lackawanna, New York, mill of Bethlehem Steel Corporation—From 1926 to 1929 he served as gas engineer for the Signal Oil and Gas Company at Signal Hill, California—From 1929 to 1931 he was associated with Southwestern Engineering Company of Los Angeles, first as research chemical engineer, subsequently being promoted to the post of director of research and development—From 1932 to 1936 he was design engineer for The Texas Company in New York and since then has been affiliated with Foster Wheeler Corporation in New York as engineer in charge of "light ends" petroleum process design—Coulthurst is a member of the American Chemical Society, and of the Petroleum Division of the American Chemical Society, and is a professional engineer, State of New York.

NORMAL BUTANE



ISOBUTANE



Graphic formulas such as these, in which the combining power of the elements is represented by lines, are the means by which chemists explain the phenomenon whereby two different compounds may have the same number of individual atoms, as is represented by *iso* and normal butanes.

Branched chain hydrocarbon compounds are extremely valuable in aviation and automobile fuels as they have higher anti-knock values than the corresponding normal hydrocarbons. *Iso*butane, as a branch-chained paraffin hydrocarbon, is no exception with respect to this quality, but due to high volatility, its use as a component of internal-combustion engine fuels is limited. Its greatest potential importance, however, is due to the fact that it can be used as feed stock to an alkylation unit in which it is coupled with olefines to form valuable alkylate.

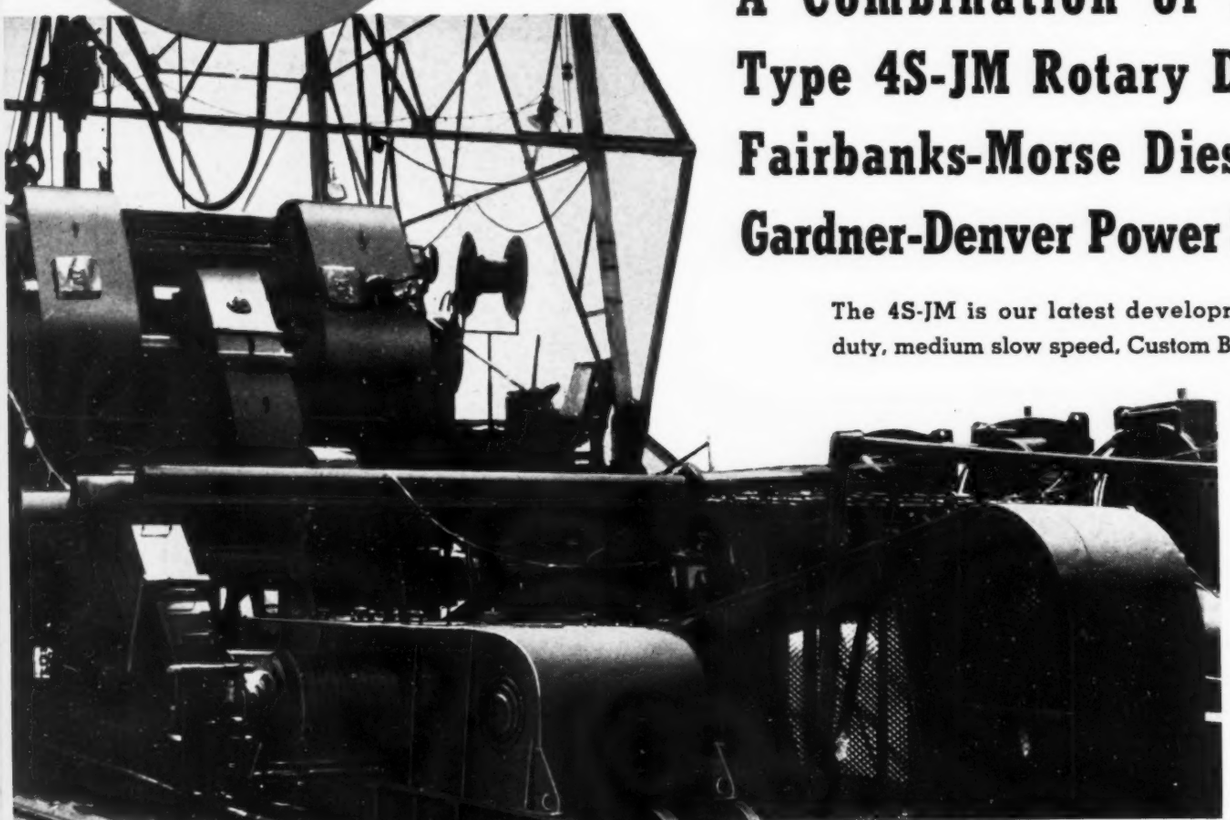
Butylenes, usually the most desirable olefines for alkylation, can be easily produced by cracking or reforming operations on a suitable charge stock; *iso*butane on the other hand is not so easily accessible. In certain localities it occurs in sufficient quantities in natural gasoline but in other places there is a marked shortage. Normal butane, on the other hand, is usually available in far greater quantities. It is, however, completely inert in the alkylation reaction.

Realizing that fundamental advantages would accrue to a process capable of converting normal butane into *iso*butane, the Shell Development Company embarked upon an extensive research program. This turned out successfully and the process is licensed

EMSCO HEAVY DUTY CUSTOM BUILT R

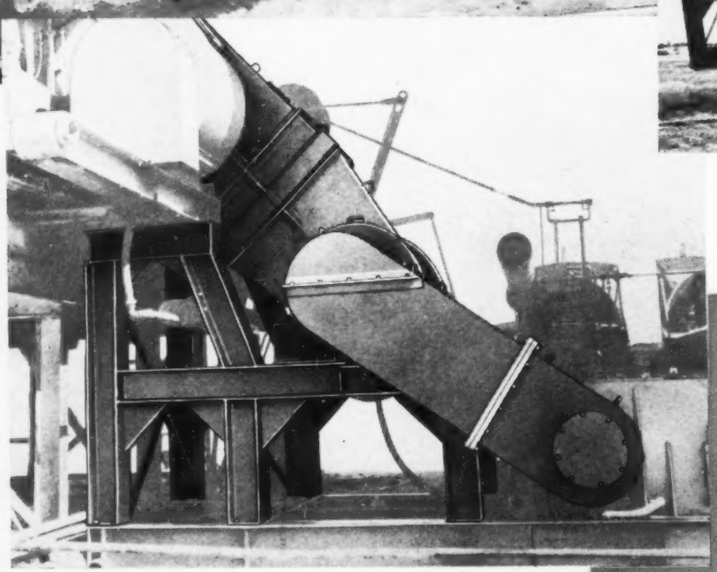
A Combination of EMSCO Type 4S-JM Rotary Drilling Rig Fairbanks-Morse Diesel Engines Gardner-Denver Power Slush Pumps

The 4S-JM is our latest development of heavy duty, medium slow speed, Custom Built Power Rigs.



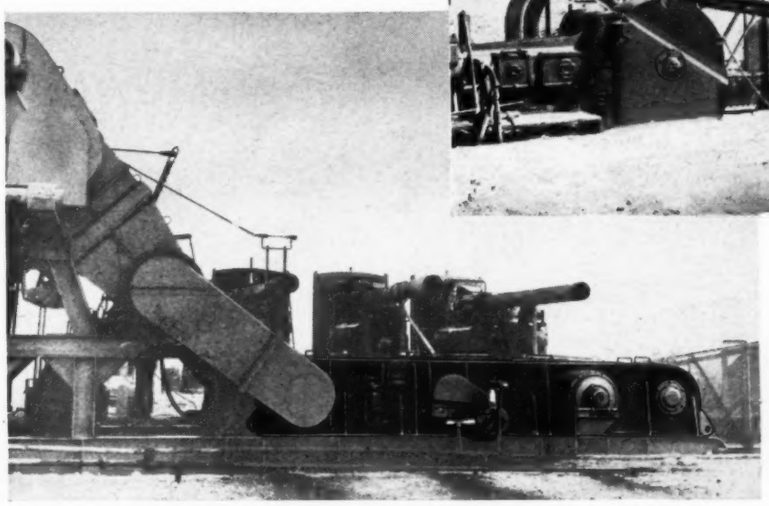
The 4S-JM Type Drilling Rig is a combination of units assembled in a manner that assures their most efficient operation and best performance.

The compounding transmission and substructure are designed to meet the highway (8 foot) regulations.



The two step drawworks substructure and drive make it necessary to raise only the drawworks to derrick floor level. With all other heavy machinery on the ground, vibration is minimized and dismantling and assembly is made easy.

ROTARY DRILLING RIG



These three Fairbanks-Morse Model 35-6 cylinder 8¾ x 10½ Diesel Engines compounded develop 975 H.P. peak hoist rating and 600 H.P. continuous duty at the rated speed of 475 R.P.M. maximum.

Flexibility of operation is the outstanding characteristic of the 4S-JM Transmission. Engines and pumps can be operated individually or in compound. Hydraulic compounding of pumps is made possible by a unique clutching arrangement in the Transmission.

• COMPOUNDING TRANSMISSION FOR GREATER FLEXIBILTY
• SHORTER DRIVES FOR HIGHER EFFICIENCY
• ONLY THE DRAWWORKS IS ON DERRICK FLOOR

The 4S-JM type drilling rig is a combination of our Emsco EB-8 speed drawworks, Emsco Type K Reverse and Friction Clutch, Emsco 4S-JM—3 engine, 4 shaft Transmission, one each 425 H.P. (8 x 20) and 250 H.P. (7¾ x 16) Gardner-Denver Power Slush Pump and 3 Fairbanks-Morse Model 35-6 Cylinder 8¾ x 10½ Diesel Engines; all assembled in a manner that assures their most efficient operation and best performance.

The two step substructure design employed in this development makes it necessary to raise only the drawworks to the derrick floor level. The rest of the machinery; engines, transmission, and slush pumps with the exception of the reverse clutch are mounted at ground level. The reverse clutch is mounted on a step of the substructure which supports the drawworks. In this manner shorter and more efficient drives can be employed and vibration is reduced to a minimum.

Fairbanks-Morse Model 35, 8¾ x 10½, 6-cylinder Diesel Engines are used as prime movers on the 4S-JM Rig. These are medium slow speed, heavy duty Diesel Engines, well known in the oil fields for their many years of thoroughly dependable and economical service on rotary drilling rigs.

The 4S-JM Transmission is designed to drive two slush pumps. Recommended for this rig is a 425 H.P. 8 x 20 FXL-FB and a 250 H.P. 7¾ x 16 FXQ-FQ Gardner-Denver Power Slush Pump.

These power pumps, the two largest of the Gardner-Denver's complete line, have been proven by many years of severe oil country service to be very exceptional equipment.

★ ★ ★ ★ ★

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SERVING THE OIL AND GAS INDUSTRIES

under patent rights of the Shell Development Company, San Francisco, California.

Isomerization is used primarily to correct deficiency of *iso*butane in the available feed stock for alkylation units. A typical analysis of a B. B. cut from a cracking unit (i.e., a cut containing butanes and butylenes) is as follows:

18 mol percent *iso*butylene
24 mol percent normal butylene
22 mol percent *iso*butane
36 mol percent normal butane

For the satisfactory alkylation of the butylenes in such a charge stock, approximately 50 mol percent of *iso*butane would be required and, without the isomerization process, the deficiency of *iso*butane would have to be supplied from an outside source. It is now possible, however, through utilization of the isomerization process, to convert the above-mentioned normal butane content of the B. B. stock into *iso*butane and thus satisfactorily alkylate the butylenes without recourse to any outside source of naturally occurring *iso*butane.

The Process

General. The essential features of the isomerization process are as follows:

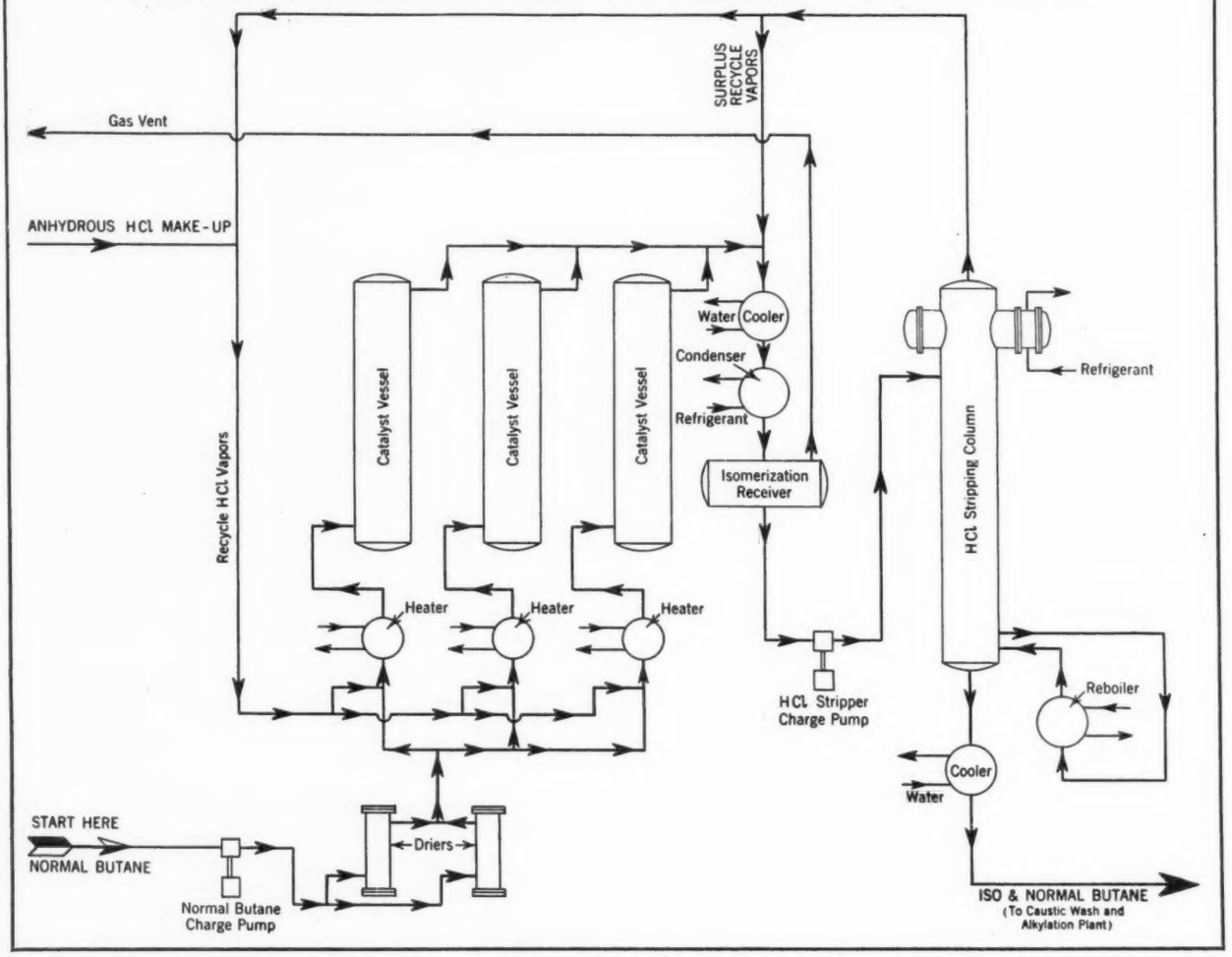
Normal butane in vapor form is passed through a granular mass of catalyst that contains aluminum chloride. A carefully controlled quantity of anhydrous hydrogen chloride is added to the butane vapors. The isomerization reaction takes place under mild conditions of temperature and pressure giving a product from the catalyst vessels containing very little except *iso*butane, unreacted normal butane, and hydrogen chloride. These products are condensed by the use of a refrigerant, and the liquid butanes containing hydrogen chloride in solution are passed to a stripping tower in which they are freed from hydrogen chloride. The butanes are next carried, via a neutralizing system, into an adjacent alkylation plant whereas the hydrogen chloride coming from the stripper is passed back once more through the catalyst vessels. The normal butane is segregated in the fractionation section of the alkylation plant and is once more charged to the isomerization unit.

Charge stock. Charge stock for an isomerization unit should consist of a relatively pure normal butane; however, the presence of propane and *iso*butane is in no way deleterious, although there is a limiting value on olefines and pentanes, depending on the economics of catalyst life.

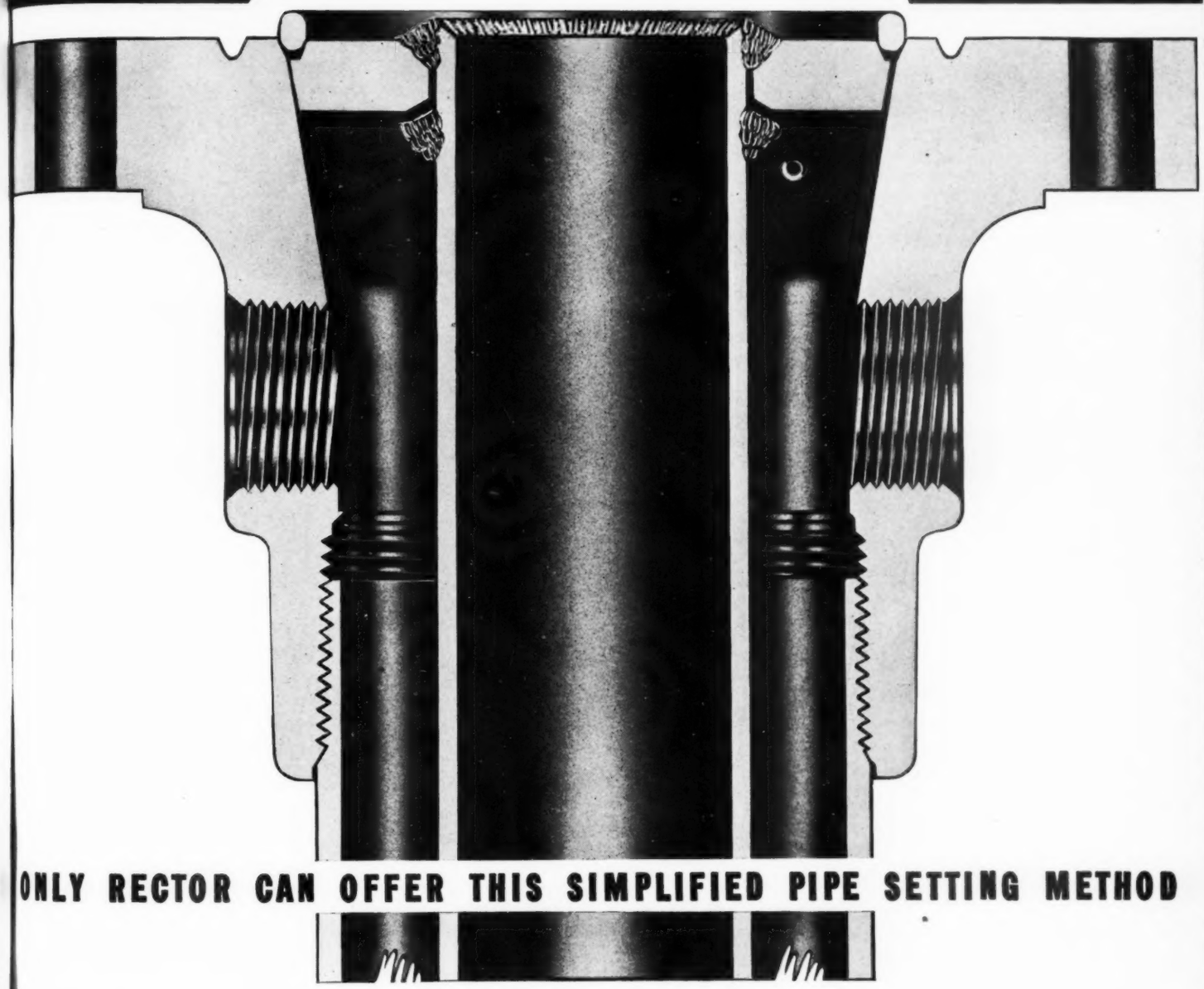
Catalyst. The catalyst consists essentially of aluminum chloride distributed on a porous support of solid inorganic material, which has been partially but not completely dehydrated by heating it at a temperature above that which it has to withstand when used in the process under reaction conditions. Among the solid inorganic compounds suitable as constituents of the catalyst mass are kaolinites, bauxite, zeolites, aluminum oxides, magnesium oxides, silicas, and similar materials.

Anhydrous hydrogen chloride. The presence in the reaction system of anhydrous hydrogen chloride gas has a beneficial effect upon the life and activity of the aluminum chloride catalyst. Consequently, anhydrous hydrogen chloride gas is continuously recycled to

Simplified flow diagram of Shell Isomerization Process converting normal butane to isobutane



Exclusive!



ONLY RECTOR CAN OFFER THIS SIMPLIFIED PIPE SETTING METHOD

This double weld arrangement in the mandrel type RECTORHEAD has given the field a safe, time-saving, easily applied, low-cost method of welding for medium depth wells. It is time-tested through hundreds of installations without a single failure.

SAFETY

The double weld raises the safety factor considerably, compared to the customary single weld. Moreover, this arrangement provides freedom from strain because the hanger is welded to the pipe only. It employs no soft packing which might be easily damaged, or which naturally deteriorates with age. It uses the A.P.I. seal ring, now accepted as the best packing means obtainable.

EASE OF SETTING

When casing is landed the operator immediately cements. No spacing of hanger is necessary. There is no hanger to be stripped over the casing as required with solid welding mandrels. With this method it is never necessary to completely "slack off" pipe. After cement sets the nippling-up job is a very simple one. The lower ring is split vertically, and dowelled, for application around the casing before cutting off. After lower ring is welded and casing is cut off, the upper solid ring is applied and welded to the casing, forming a gas-tight seal.

ECONOMY

The split hanger takes the place of slips employed in the Type RH RECTORHEAD for extremely deep wells, and thus the cost is considerably lower.

Yes, this double weld head is a remarkable advancement in simplifying the job of pipe setting . . . and it's an arrangement offered only by Rector. Call your Rector representative for full details. See the complete RECTORHEAD line of Casing Heads and Tubing Heads in your 1942 Composite Catalog.

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the reaction zone in the amount desired.

Flow sheet. The accompanying diagram shows the layout of a typical isomerization plant. Charge stock consisting of normal butane is pumped through driers that completely free it from water. This stock, together with a small quantity of anhydrous hydrogen chloride, is vaporized and passed through the catalyst vessels in which the isomerization takes place. These vessels are usually arranged in parallel so that one may be taken off stream to be recharged with fresh catalyst without affecting the operations of the plant. The flow of hydrogen chloride to each set of catalyst vessels is carefully controlled, as its proportion to normal butane must be varied according to the age of the catalyst.

The heat of reaction is mildly exothermic, consequently the catalyst can be maintained at the required temperature by utilizing this heat with little, if any, addition from outside.

Vapors issuing from the catalyst vessels are passed to a water cooler followed by a refrigerated condenser, wherein total condensation is effected and the liquid is collected in the isomerization receiver. The pump withdraws liquid from this receiver and discharges it into the hydrogen chloride stripping column. The charge is denuded of absorbed hydrogen chloride, which is released from the top of the stripping column, and returned to the entrance of the catalyst vessels. Excess hydrogen chloride gas is passed directly back to the isomerization receiver where it is reabsorbed in the liquid. A reboiler at the base of this column supplies heat necessary for stripping but if thorough stripping is required a refrigerated condenser supplies a certain amount of liquid reflux to the column top. The mixture of normal and *iso*butane is withdrawn as bottoms product through a water-cooled heat exchanger, passed to the fractionation section of the alkylation plant, and the two are separated by distillation. The normal butane is then recycled to the isomerization plant; thus in effect, practically all the normal butane in the original butane-butylene charge stock to the alkylation plant is convertible into *iso*butane.

Yield. Theoretically, under the conditions prevailing in the catalyst vessels, about 68 percent of *iso*butane would be in equilibrium with normal butane. A once-through pass operation normally converts 40 to 45 percent of the normal butane charge into *iso*butane.

Side reactions. The main reaction occurring is a straightforward isomerization of normal butane to *iso*butane. In the course of time, however, small quantities of gases such as methane and ethane, which are produced by side reactions, tend to accumulate in the recycled hydrogen chloride. These materials are vented from the system. The point selected for venting is the vapor space in the accumulator where the liquid products from the catalyst chamber are collected after condensation.

Equipment

Ordinary standard types of equipment are used in the design of a butane isomerization unit. Anhydrous hydrogen chloride causes a negligible amount of corrosion to steel and iron; therefore, in general, carbon steels are used as suitable materials of construction. However, upon contact with the atmosphere, it becomes very corrosive due to its ability to absorb moisture quickly, resulting in the formation of dilute hydrochloric acid. Because of this characteristic, care must be taken to use special metals in locations where minute leaks may be expected. It is evident that screwed fittings should be avoided wherever possible, and when used, they should be back-welded if it is practical to do so.

Application

Petroleum refiners having sulphuric acid catalytic alkylation facilities, but a deficiency in *iso*butane, will find butane isomerization economically applicable as a means of converting normal butane to one of the constituents necessary in producing valuable alkylate.

Conclusion

The rapid expansion in number of alkylation plants has caused a shortage of *iso*butane in many localities. Isomerization of normal butane to *iso*butane offers an economical, inexpensive, and simple means of overcoming this shortage; it has become, therefore, a highly important study for refinery engineers generally, and undoubtedly will fill an essential need in the economic scheme of manufacturing high octane gasoline.

Acknowledgment

Acknowledgment is made to the Foster Wheeler Corporation for granting permission to publish this material.

——☆☆☆——

P 629.

"Freezing" of Natural Gas Pipe Lines Studied

"FREEZING" of natural gas pipe lines in cold weather by the formation of snowlike compounds called gas hydrates is being investigated by the U. S. Bureau of Mines through temperature surveys of certain Western pipe lines, according to a report submitted by Dr. R. R. Sayers, Director of the Bureau, to Secretary of the Interior Harold L. Ickes.

The gas hydrates form in pipe lines at temperatures as high as 60°F., the report revealed, and their elimination constitutes a major engineering problem in the transmission of natural gas through pipe lines. Moisture condenses in the pipes and unites chemically to form the ice-like substance. To predict the formation of gas hydrates and to study possible control methods, according to the report, it is necessary to know the temperature of buried pipe lines transporting the gas.

Bureau chemists established temperature-reading stations on a 340-mile natural gas pipe line extending from the Texas Panhandle gas fields to Denver, Colorado, and control stations where the temperatures were recorded at the surface and at various depths to a maximum of 10 ft. below the ground level, the report stated. Measurements at those stations for nearly four years showed that the temperature of the gas in the pipes generally approximated the temperature of the ground at the depth of the center of the pipe, rising in summer and falling in winter.

Fluctuations in the temperature of the gas as it crossed under a river bed were recorded by thermometers installed in the pipe line on either side of the river. Some decrease in temperature of the gas due to cooling of the earth by the river water was noted, but even when the river was full of ice the gas flowing at a temperature of 42°F. was cooled only to 40°F. by the river crossing.

The report describes the method of obtaining the temperatures and contains continuous temperature records taken at 10-mile intervals along the pipe line.

A copy of the report may be obtained by writing to the U. S. Bureau of Mines, Department of the Interior, Washington, D. C., for Report of Investigations 3590, "Temperatures of Natural Gas Pipe Lines and Seasonal Variations of Underground Temperatures," by W. M. Deaton and E. M. Frost, Jr.

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Why shouldn't he when the last well on the lease was switched to Axelson Sucker Rods last week. Took him nearly two years to get everybody to see things his way, but it was worth the effort.

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Rod trouble today is the least of his worries. Why don't you put yourself in the same spot?

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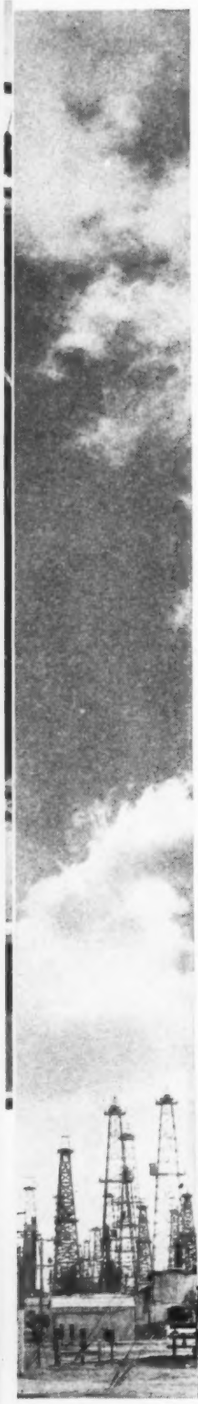

● The thousands of oil derricks that bristle from our immense oil fields are the spearheads of our war power. They symbolize Oil—the life-giving fluid for ships, planes and tanks that mean power in action.

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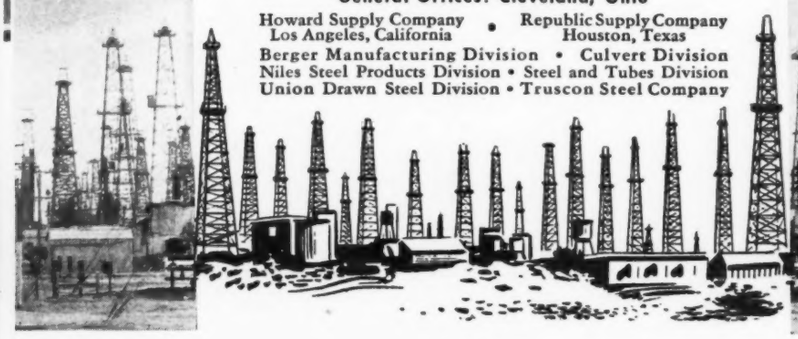
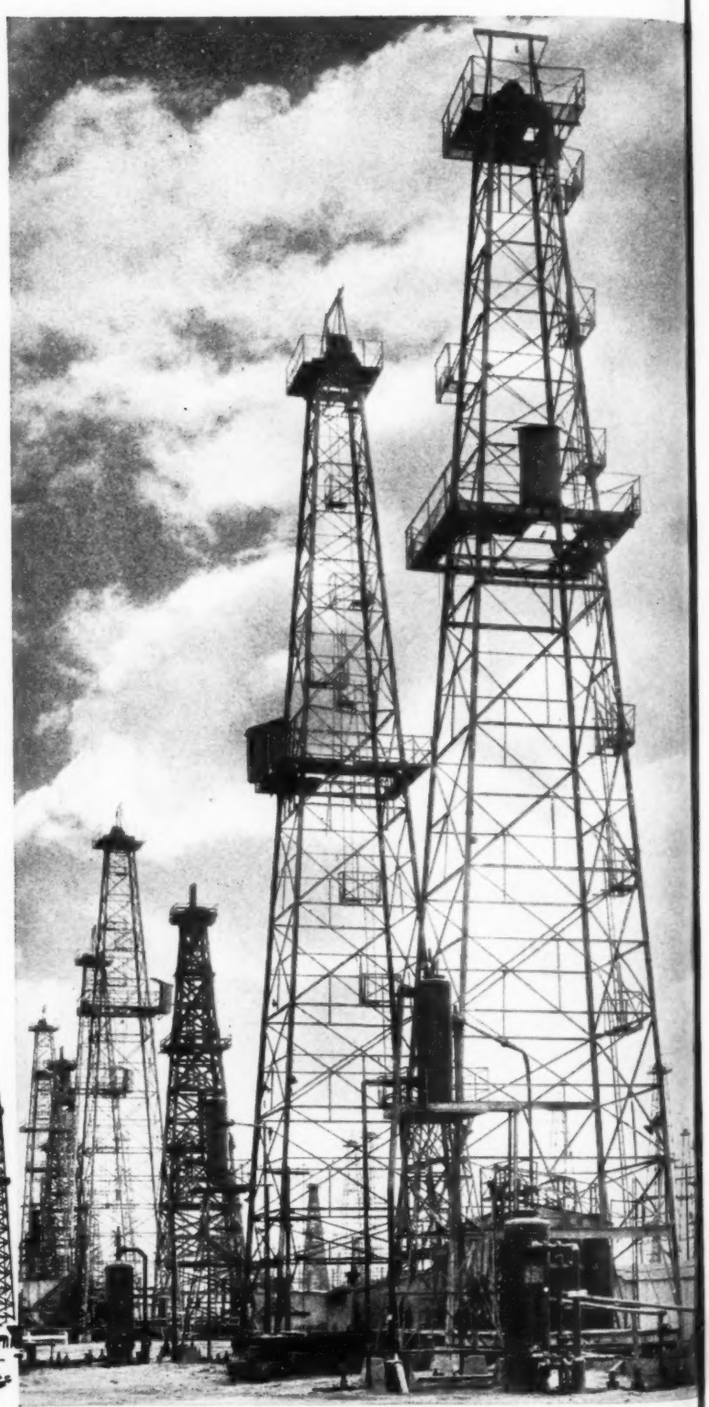




REPUBLIC *Electric Weld*

LINE PIPE...NORMALIZED CASING AND TUBING

P 023.1
P 911.11

The Petroleum Industry in 1941

by William R. Boyd, Jr.
President, American Petroleum Institute

THE declaration of the existence of a state of war with the Axis powers found the American petroleum industry working at break-neck speed, with the thorough-going coöperation of the government, to meet new demands for petroleum products, and to eliminate bottlenecks before they have a chance to affect the supply of petroleum.

On the very day Congress was acting to meet the treacherous attack of Japan, Petroleum Coördinator Harold L. Ickes, with keen foresight and patriotic resolve, was organizing a Petroleum Industry Council for National Defense—a sort of partnership arrangement between the federal government and the petroleum industry, to have petroleum play its all-important part in prosecuting the war.

Demand for petroleum products in 1941 was by far the greatest in the 80-year history of the industry, amounting to nearly 1,600,000,000 bbl., or almost 10 percent above 1940. United States consumption alone increased more than 12 percent. At the end of the year the industry was producing crude petroleum at a rate of more than 4,100,000 bbl. a day, with predictions made that rapidly mounting needs would require production of 4,500,000 bbl. a day by the middle of 1942, and possibly of 5,000,000 bbl. a day by July 1, 1943.

The petroleum industry, by its very nature, is so integrated from oil well to consumer that almost any operating change in one small part of the industry has its inevitable reaction in other branches of the industry thousands of miles away. Defense demands already have made many such changes imperative, and more will come.

In order that these changes might be made with complete fairness to all elements of the industry, and that the industry might make its maximum coöperative contribution to national defense without any hindrance because of possible illegality, the President on May 28 appointed Secretary of the Interior Harold L. Ickes as Petroleum Coördinator for National Defense. With the coöperation of the industry and of dozens of regional committees of oil men, he has prudently and effectively met the problems that so far have appeared, and actively is working closely in coöperation with the industry to assure completely adequate supplies of petroleum for all national defense needs in the future.

WILLIAM R. BOYD, Jr.

was born at Fairfield, Texas, January 7, 1885—Was educated in the Fairfield schools and his first job was as printer's devil on the *Fairfield Recorder*—At 16 he acquired a general merchandising store in Fairfield, but abandoned it to study law under his father—At the age of 19, though a minor, he was admitted to the Texas bar by a special dispensation, and became secretary to Congressman Scott Field of the Sixth District of Texas—Returning to Texas, he practiced law at Teague and was elected its first mayor at the age of 21—Subsequently he organized and was for two years president of the Farmers and Merchants Bank of Eddy, Texas—When Congress was considering enactment of the Federal Reserve Act, Boyd took part in a national campaign seeking banking reform legislation—Later he became campaign manager of the League to Enforce Peace, formed by William Howard Taft—For several years he worked in support of President Wilson's effort to have the United States join the League of Nations—Boyd joined the staff of the American Petroleum Institute in 1920 as assistant general secretary and counsel—He was elected executive vice-president of the Institute in 1929, and in 1941 its ninth president—In 1934, Boyd served as chairman of the Board of Review, the court of appeals under the petroleum code—In June, 1934, he was granted the honorary degree of Doctor of Laws by St. Bonaventure College—On December 8, 1941, he was elected chairman of the Petroleum Industry Council for National Defense, created by Petroleum Coördinator Harold L. Ickes.

On December 1, 1941, this government-industry coöperation was put on a more formal basis with the appointment of a national Petroleum Industry Council for National Defense, charged by the Coördinator with advising him and considering on its own motion matters relating to the coördination of the industry, and taking any action recommended by the Coördinator. The Council is composed of representative oil men from all branches of the industry.

During 1941 the industry was concerned with a number of potentially serious problems, among them the threat of a deficiency of petroleum supplies on the East Coast, huge additional demands for 100-octane super aviation motor fuel, reduced supplies of raw materials for the manufacture of tetraethyl lead, and the need for high priorities to assure the continuing normal operations of the industry.

To meet these and other national defense emergencies, the petroleum industry spent hundreds of thousands of dollars in new capital expenditures during 1941, for new refining equipment, new pipe lines, and new tankships, along with the regular capital expansion of the industry. Shipyards turned out many new high-speed tankships in record time during the year, and many others are being built or are on order for oil companies and the Maritime Commission, with completion scheduled for 1942 and 1943.

Two national defense pipe lines—a 250-mile crude oil line from Portland, Maine, to Montreal, Canada, and a 450-mile products line from Port St. Joe, Florida, to Chattanooga, Tennessee—were completed before the end of the year, and a third products line, 1260 miles long, from Baton Rouge, Louisiana, to Greensboro, North Carolina, is nearing completion.

Capacity of American refineries to produce 100-octane aviation motor fuel increased to almost 44,000 bbl. daily (50,000 bbl. or 2,100,000 gal. with a greater proportion of tetraethyl lead) by the end of 1941, and plans sponsored by the Petroleum Coördinator call for quadrupling this huge capacity within the earliest possible time. The present capacity for this one grade of aviation fuel alone is far greater than the total capacity of the rest of the world combined, and is seven and one-half times the U. S. consumption of all grades of aviation fuel as recently as 1938.

All agencies of the federal government having to do with petroleum and petroleum product production and transportation are busily engaged in working out coöperatively with the industry every problem as it arises. The Office of Petroleum Coördinator for National Defense is functioning with great intelligence and effectiveness. The state regulatory agencies and the Interstate Oil Compact Commission are geared into the program. And the petroleum industry and all its units are going to do a magnificent job!

The detailed 1941 figures covering

the operations of the petroleum industry, estimated for the most part by the Institute, reveal that practically every figure is a new all-time high record. Crude oil production in the United States totaled 1,405,218,000 bbl., compared with 1,353,214,000 bbl. in 1940, but production in the rest of the world is believed to have declined slightly in 1941 to 809,399,000 bbl. from 823,548,000 bbl. The U. S. proportion of the world total therefore increased slightly to 63.5 percent.

U. S. consumption of petroleum and products increased almost 12 percent to an estimated 1,478,697,000 bbl., but exports declined again to 105,909,000 bbl. to make total demand 1,584,606,000 bbl. Stocks of crude petroleum were reduced about 20,000,000 bbl. during the year, ending at 244,000,000 bbl., but stocks of refined products on December 31, 300,000,000 bbls., were virtually equal to the January 1, 1941, stocks.

Drilling of wells increased slightly to 31,299, second busiest drilling year in the industry's history. Of the 1941 wells, 21,584 were completed successfully as oil wells and 2,869 as gas wells. The remaining 6,846 were dry holes.

The country's refineries processed a record 1,406,976,000 bbl. of crude petroleum in 1941, and met new peak demands for all major products except kerosine. Total domestic and export demand for these products, with high domestic demands more than making up the further decreases in exports, were: motor fuel, 683,843,000 bbl.; distillate fuel oil, 188,513,000 bbl.; residual fuel oil, 395,527,000 bbl.; kerosine, 71,400,000 bbl., and lubricating oil, 41,500,000 bbl.

The most spectacular increase was reported in the domestic demand for lubricating oil, which gained nearly 30 percent over 1940. Exports of lubricating oil also declined less than the exports of any other major product.

Wholesale prices of petroleum products, according to the Bureau of Labor Statistics, remained far below the average for all commodities, but rose from an average index of 50.0 in 1940 to 57.2 for the first 10 months of 1941. This compares with an average of 87.1 for all commodities. Crude oil prices, as indexed by the 36-deg. Oklahoma-Kansas quotation, increased from $1.02 in 1940 to $1.17 at the end of 1941.

☆☆☆

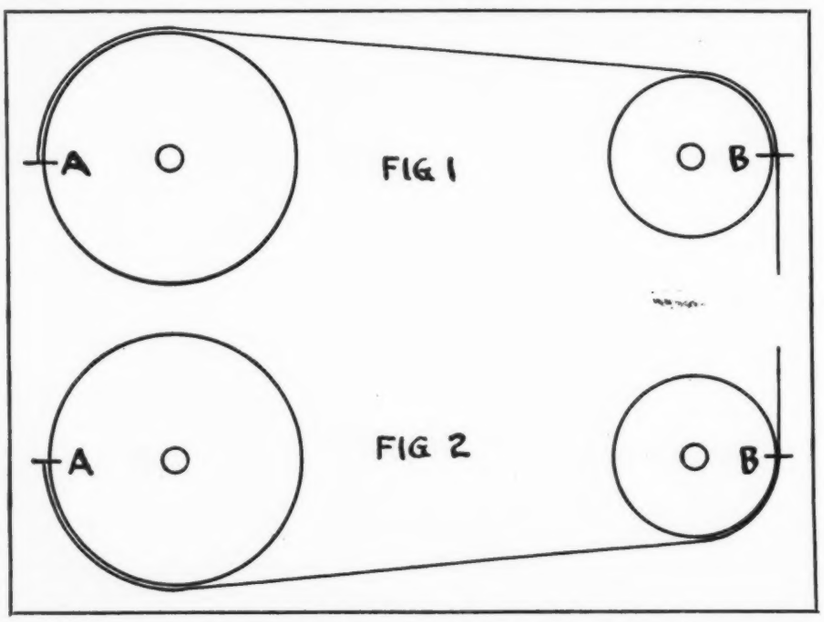
P 094.6

Aids in Belt Power Transmission

by W. F. Schaphorst

FIGS. 1 and 2 show the quickest way to measure the exact distance around two pulleys when measuring for a belt, band saw, rope, cable, etc.

Very often a steel tape is not long enough to reach entirely around the pulley, and even if it does often is a cumbersome method because of obstructions and the necessity of running back and forth with the tape. Using the method here discussed, even if the tape is not of sufficient length is not important.



This is really a "two-man job". One man makes a mark on his pulley at A and the other makes a mark on his pulley at B. Measure the distance around the tops of the pulleys from A to B as shown in Fig. 1. Then measure the distance around the bottoms of the pulleys from A to B as shown in Fig. 2. Add the two measurements and you have the distance around the pulleys.

Of course the end of the tape is held precisely at A in making both measurements. The readings are taken at B.

It is obvious that this method is particularly valuable when it is desired to know the exact lengths of belts on a long line shaft. The two men can proceed from one end of the shaft to the other in an orderly and efficient manner without running back and forth with the end of the steel tape. In using this method there are seldom any obstructions.

Another useful power transmission idea is shown in Fig. 3. If the space "G" between two pulleys is less than 1.5 times the width of the widest adjacent belt, the condition may be dangerous. In the event that the belt runs off its pulley it is likely to get caught between the pulleys and be broken or ruined, and it may pull the shafting, pulleys, and hangers down onto the heads of the workers below.

This condition is easily remedied by placing a pulley in the vacant space, as shown in the sketch, so that the belt cannot drop into the space and become caught. The diameter of this additional pulley should not be less than that of the smaller pulley and not greater than the larger pulley.

Also, when a belt runs off a pulley placed adjacent to a hanger, the situation is hazardous unless provision is made to prevent catching of the belt between the hanger and pulley. This usually can be done by attaching a hook or guard to the hanger in such a way that the belt will drop onto the hook or guard when it runs off the pulley. Entangling will then be impossible.

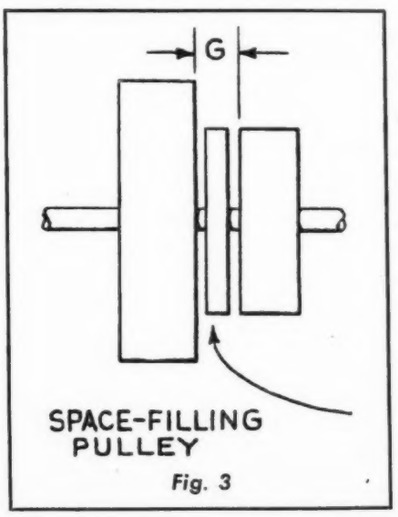


Fig. 3

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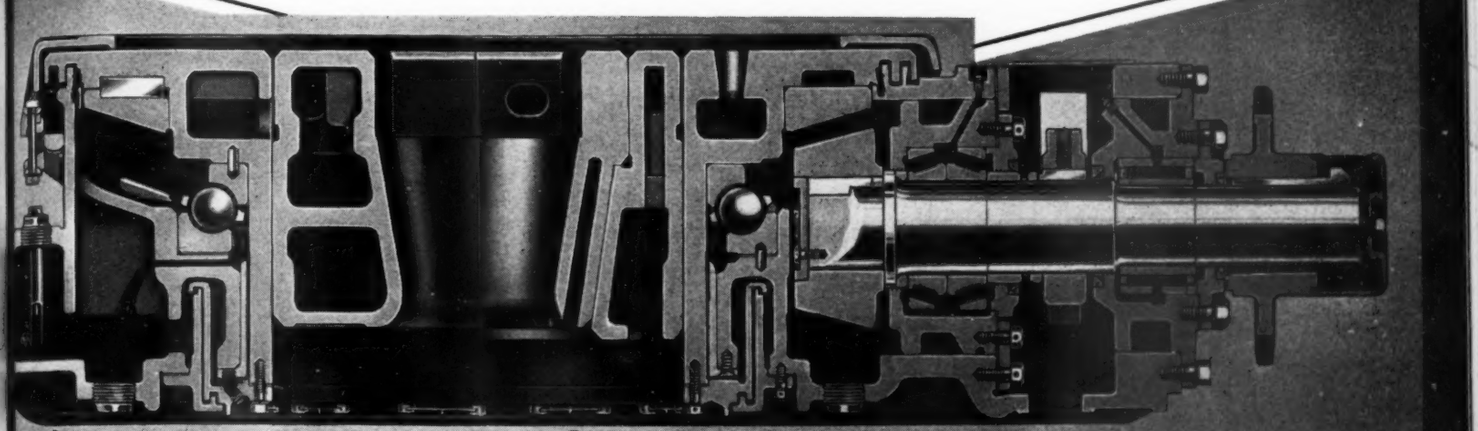
Here's why your driller prefers "OILWELL" Rotaries



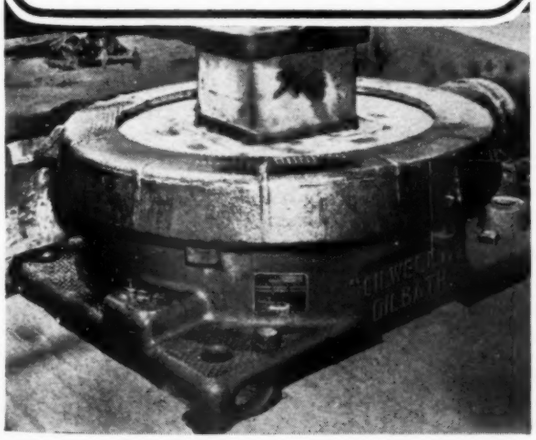
Constant and Ample Lubrication

is the best assurance of long, efficient life. Illustrated in solid orange is the continuously circulating oilbath lubrication of the "Oilwell" 27½-A and 17½-inch Oilbath Rotaries. Oil picked up by the pinion and thrown from the gear is conducted by troughs in a steady stream to the main bearing. Part of the flow continues through the radial and hold-down bearing, keeping it constantly immersed in a shock-absorbing oil-cushion. Overlapping of the hold-down ring and oil-retainer ring insures complete return of the lubricant as it continues its circulating flow back to the reservoir.

Time-proved labyrinths at both the top and bottom effectively seal the oilbath enclosure and prevent intrusion of foreign matter. Shaded orange illustrates the separate lubrication of the pinion-shaft roller bearings in their sealed enclosures.

To maintain a constant oil pressure at the extreme speeds (up to 1000 r.p.m.) for which it is designed, the "Oilwell" 21-inch Super-Speed Rotary is provided, in addition to the splash system, with forced-feed lubrication throughout, including pinion shaft roller bearings.

"Oilwell" 17½-inch Oilbath Rotary.



IN times of emergency, rotaries, like men, are counted on to stand up and render efficient, reliable service as long as the need exists. Performance records show that "Oilwell" Rotaries have what it takes in reserve capacity, durability and *lasting* efficiency. Here are some of the reasons for this performance:

★ **Ample Capacity**

	17½-inch Oilbath	21-inch Super-Speed	27½-A Oilbath
Rated Drilling Depth	7,500 ft.	17,000 ft.	17,000 ft.
Dead Load Capacity	200 tons	300 tons	300 tons
Max. Table Speed	400 r.p.m.	1,000 r.p.m.	400 r.p.m.

★ **Fully heat-treated, spiral-bevel gear and pinion with the pinion given an additional surface hardening.**

★ **High-speed, self-centering, angle-contact main bearing with large-diameter, high-precision balls and through-hardened and ground high-carbon, alloy-steel races.**

★ **Heavy-duty bronze radial and hold-down bearing.**

★ **Compact and sturdy unit-assembly of the fully heat-treated pinion shaft, its bearings, bearing housings and locking wheel.**

★ **Rigid cast-steel base with integral skids, table enclosure, and cylindrical supports for the pinion-shaft bearings.**

★ **Constant and ample lubrication — see illustration and description.**

OIL WELL SUPPLY COMPANY

Oil-Field Trailers Made Sturdy and Light by Arc-Welding

by A. F. Davis

Vice-President, The Lincoln Electric Company, Cleveland, Ohio

PETROLEUM ENGINEER Exclusive Feature

TRAILERS used in the oil fields must be strong yet light in weight to enable them to carry heavy machinery and equipment over rough oil-field roads. The Hobbs Manufacturing Company, Fort Worth, Texas, utilizes arc-welding to accomplish these two requirements and at the same time speed production and lessen cost.

An old-type trailer formerly made by the company is shown in Fig. 1. This 1929 model was difficult to build because of the necessity for drilling holes accurately to make fastenings in parts that were practically inaccessible.

Fig. 2 shows a modern arc-welded trailer produced by the company. This model employs pressed steel channels, angles, flat bar stock, shear-cut plate and pipe—all arc-welded together, to form a rigid unit. The concern uses equipment supplied by The Lincoln Electric Company of Cleveland, Ohio.

The unit shown in Fig. 2 has a capacity of three tons and weighs approximately 2840 lb.—about 25 percent less than the former construction. An example of the savings is shown in the case of the bolster mounting, which in this arc-welded model cost $9.88, as compared to $15.10 for the former one.

A special trailer framework of a somewhat different type manufactured by the company is shown in Fig. 3. This employs 4-in. channels for flooring and pressed steel stringers and columns made from 16-ga. steel.

A picture of a welder working on a trailer is shown in Fig. 4. The welder is finish-welding a spring bracket hanger for a special trailer. The type of Lincoln welder used by the concern is shown in Fig. 5.

☆☆☆

Fig. 5

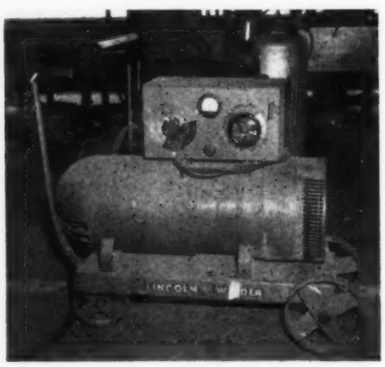


Fig. 1

Fig. 2

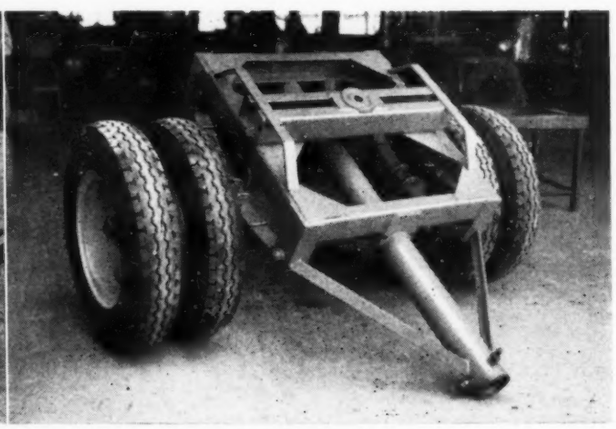


Fig. 3

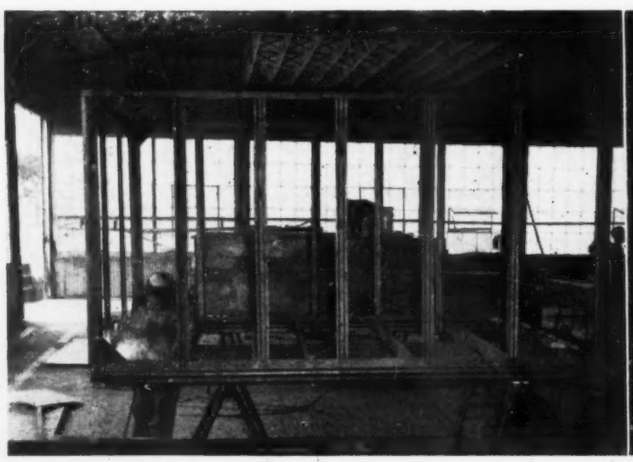
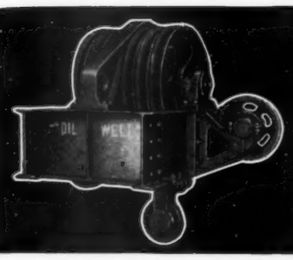


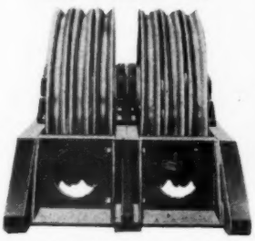
Fig. 4



Distinguished Equipment with distinctive Roller Bearings...

AMERICANS!

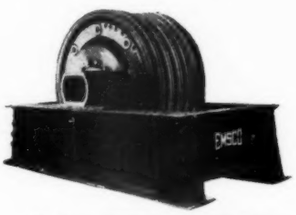
The Oil Well Supply Company



The American Well & Prospecting Company

Oil Well Supply Company

The American Well & Prospecting Company



The Emsco Derrick & Equipment Company

Emsco Derrick & Equipment Company

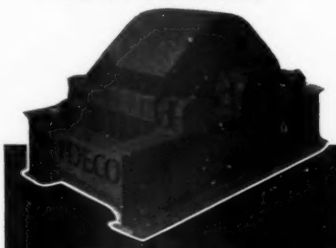
The Brewster Company, Inc.

The Brewster Company, Inc.

The Wheland Company

International Derrick & Equipment Division of International-Stacey Corporation

The Wheland Company



International Derrick & Equipment Division of International-Stacey Corporation

Handling tremendous loads . . . mastering terrific strains and impacts... hauling hundreds of tons of pipe up and down the hole... imposes punishment on modern Crown and Traveling Blocks that only truly great Roller Bearings can withstand.

It is significant that more heavy-duty Blocks are equipped with AMERICAN Roller Bearings than with any others! For the distinguished equipment shown here... as well as for others ... *only* AMERICAN Roller Bearings are considered good enough to deliver the trouble-free service demanded by an exacting industry.

No load's too great, no strain too severe for these oilfield-engineered bearings. Absolute precision combines with adequate reserve strength to make "Americanized" rig equipment operate with speed and velvety smoothness under the most strenuous conditions. Specify "Americans" when you buy new equipment; when you build equipment consult American Roller Bearing Company engineers for practical advice and technical facts.

AMERICAN ROLLER BEARING CO.
PITTSBURGH, PENNSYLVANIA
Pacific Coast Office: 1718 Flower St., Los Angeles, Calif.

AMERICAN
HEAVY-DUTY ROLLER BEARINGS

LAUGH WITH BARNEY

First Doctor: I had an unusual case today.

Second Doctor: What was it?

First Doctor: I attended a grass widow with hay fever.

* * *

Traffic Cop: Use your noodle, lady! Use your noodle!

Lady: My goodness. Where is it? I've pushed and pulled everything in the car.

* * *

The boat had just left Portland when a sprightly little flapper stowaway was discovered in a life boat. The captain ordered her sent to his cabin.

"I don't know what to do with you, I'm sure," he said as he questioned her.

"Say, skipper," she said finally, "how long have you been a sailor?"

* * *

"You can always tell a lady by the way she dresses."

"Well, a real lady would pull down the shades."

* * *

"What are you doing in the cellar?" demanded the rooster.

"If it's any of your business," replied the hen, "I'm laying in a supply of coal."

* * *

"Johnny, give the definition of home."

Johnny: "Home is where part of the family waits until the others are through with the car."

* * *

Boy Friend: Are you free this evening?

Girl Friend: Well, not exactly free, but very inexpensive.

* * *

At the last home talent golf tournament the club secretary caught one of the entrants driving off about a foot in front of the teeing mark.

"Here!" he cried indignantly, "you can't do that. You're disqualified!"

"What for?" demanded the golfer.

"Why, you're driving off in front of the mark."

The player looked at the secretary with pity.

"G'wan back to the clubhouse," he said tersely. "I'm playin' my third stroke!"

* * *

Teacher: Willie, how do you define ignorance?

Willie: It's when you don't know something and someone finds it out.

A southern sportsman, against his better judgment, loaned his champion Irish setter to a visiting Chicago executive. The host had to go into town to attend to some business. When he returned home late that night he asked the visitor how he liked the dog.

"Well," said the man from Chicago, "we didn't get a hundred yards away from the house till that dog stopped with his tail pointed straight out, one forefoot raised and his nose pointed toward a clump of grass. I had to kick hell out of him before he would go on and hunt."

* * *

Science Prof: What happens when a body is immersed in water?

Coed: The telephone rings.

* * *

Ticket Agent: This ticket to the west coast costs you $100 and allows you a three-day hangover in Chicago.

Thrifty Miss: And how much if I don't get drunk in Chicago?

* * *

There once was a lady named Eve,
Who caused husband Adam to grieve,
When he asked where she'd been,
She replied with a grin,
"I've been absent without any leave!"

* * *

Mountain Guide: Folks, be careful here! It's dangerous. But if you do fall, remember to look to the left. You get a wonderful view.

* * *

Landlady (in hall talking to a gal): I thought I saw you taking a gentleman up to your apartment last night, Miss Smythe.

Miss Smythe: Yeah; that's what I thought!

* * *

She: Fresh, who said you could kiss me?

He: Everybody.

* * *

Two actors who were jealous of each other met in a pub. They exchanged frigid nods.

"How are you getting along?" asked one presently.

"Pretty well," replied the other. "Still keeping alive."

The first man eyed his rival steadily for a second and then asked casually: "What's your motive?"

* * *

"What makes people walk in their sleep?"

"Twin beds."

Man (rushing into Fire House): Say did you know I have a fire at my house?

Fire Chief (playing solitaire): How absurd! With the weather so warm, too.

* * *

He: You are always wishing for something you haven't got.

She: What else can one wish for?

* * *

"Dull party, isn't it?"

"Yes, very."

"Let's go home."

"I can't, I'm host."

* * *

Motorist: What is your idea of a gentleman farmer?

Farmer Southforty: A person who is so well fixed that he can waste profanity on a golf ball instead of on a mule.

* * *

Women's faults are many;
Men have only two:
Everything they say,
And everything they do.

* * *

"Who are those people who are cheering?" asked the recruit as the soldiers marched to the train.

"Those," replied the veteran, "are the people who are not going."

* * *

"Look at that little midget across the street!"

"Yes. His father was a Scotchman."

* * *

To his Negro company of the 367th Infantry at Camp Claiborne, Louisiana, a black first sergeant spoke dire words: "From now on when Ah blows dis yere whistle, Ah wants to see a huge impenetratable cloud of dust come boilin' outa them tents. And when 'at dust clears away, Ah wants to find three rows of statues."

* * *

"What happened after you were tossed out of the side exit?"

"I told the waiter I belonged to a very important family."

"So what?"

"He begged my pardon, asked me in again and threw me out the front door."

* * *

Son: Dad, what was your great ambition when you were a boy?

Dad: To wear long pants. And I've had my wish. If there is anybody else in the country that wears his pants longer than I do, I'd like to see him.

* * *

A news item reports that a four-year-old boy who had not spoken before startled his parents by suddenly remarking: "This is a helluva world!"

Instead of talking that kid had been thinking.

HERE'S THE BUGABOO OF SUCCESSFUL CEMENT JOBS

CHANNELING

. . . and you can't get rid of him by merely saying "scram." But you can reduce him to about this size

by using Baker Cement Wash-Down Whirler Equipment. The definite downward as well as upward whirling action afforded by this equipment provides the best possible opportunity of a more nearly complete encasement of the pipe at the critical point, the shoe joint, with a uniform body of cement, thus reducing the hazard of channeling to a minimum.

The efficiency of Baker Cement Wash-Down Whirler Equipment, which was introduced and developed by Baker engineers, has been demonstrated in thousands of successful cement jobs. And it is generally acknowledged today as being the most efficient type of cementing unit available.

The Baker Wash-Down Whirler Principle is available in several types of units . . . a Baker Cement Wash-Down Whirler Float Shoe; a Baker Cement Wash-Down Whirler Guide Shoe; and a Baker Cement Float Collar in combination with either type of Whirler Shoe.

For detailed information, refer to page 222 of the 1941 Composite Catalog, or get in touch with your nearest Baker office or field representative.

Product No. 120

Quick FACTS Concerning BAKER CEMENT Wash-Down WHIRLER Float Shoe

It Provides . . .

(1) Safe Guiding and Floating
(2) Efficient Washing Action
(3) Positive Acting BALL-TYPE Back-Pressure Valve
(4) Cementing Efficiency
(5) Easy Drillability

BAKER CEMENT GUIDING, FLOATING, CEMENTING EQUIPMENT

BAKER OIL TOOLS, INC.

Main Office and Factory: 6000 So. Boyle Avenue
P. O. Box 127, Vernon Station, Los Angeles, California
Central Division Office and Factory: 6023 Navigation Boulevard
P. O. Box 3048, Houston, Texas
Export Sales Office: 19 Rector Street, New York, N. Y.

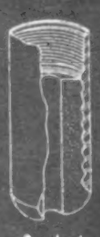
Product No. 100

Baker Cement Float Shoe

Baker Cement Float Collar

Product No. 101 M&F

Baker Cement Guide Casing Shoe



Product No. 102

Baker Cement Wash-Down Whirler Float Shoe

Product No. 120

Baker Cement Wash-Down Whirler Guide Shoe

Product No. 121

Baker Cement Whirler Float Collar with Solid Bottom Baffle with Metal "Petal" Basket

Product No. 306

Running Tour

WITH MEN IN THE INDUSTRY

F. R. GAMMON has been named to succeed JAMES R. MILLS, retired, as manager of sales of the Carnegie-Illinois Steel Corporation.

JOSEPH JENSEN, chief petroleum engineer, Tide Water Associated Oil Company, has been elected a director of the Los Angeles, California, Chamber of Commerce. Jensen is well known as an indefatigable worker in community affairs in the petroleum industry.

STANLEY B. WHITE, assistant chief geologist of the Ohio Oil Company, delivered an address to members of the Tulsa Geological Society on "The Davenport Pool of Lincoln County."

HAROLD GRAY, London, England, representative for Reed Roller Bit Company, has accepted a commission as lieutenant in the British Army. Gray will perform special duties overseas.

I. N. JOHNSON, 53, president of the Johnson Oil Refining Company, died at his home in Evanston, Illinois, December 14. He is survived by his widow, two children, and two brothers.

J. A. TRAUGHBER is now in the Hutchinson, Kansas, office of Transwestern Oil Company as superintendent. He was formerly in the production office of the company in Oklahoma City, Oklahoma.

A. J. NAGEL succeeds S. G. BUFORD, resigned, in the safety department of the Cities Service Oil Company in Oklahoma City, Oklahoma, Frederick, and Duncan, Oklahoma, and north Texas areas. Nagel will continue as representative of the industrial relations department at Oklahoma City and will continue to have charge of company houses there.

JESS RECTOR, drilling and production superintendent for Western Drilling Company in the southern Alberta, Canada, division, is now in Los Angeles, California, after the winter shutdown of the company's operations in Alberta.

R. T. MCNALLY, who is superintendent of the Panhandle Division of Shell Oil Company, is the new chairman of the Panhandle Chapter of the American Petroleum Institute. A. J. BEAGLE, Rock Glycerin Company, has been made vice-chairman, and NORMAN PERKINS, Phillips Petroleum Company, second vice-chairman.

IKE LOVELADY of Black, Sivalls and Bryson, Inc., Oklahoma City, Oklahoma, recently spoke before the Seminole Chapter of the American Petroleum Institute on "Emulsions, Their Cause and Cure."

C. V. MILLIKAN, chief engineer, Amerada Petroleum Corporation, Tulsa, Oklahoma, delivered an address before the student section of the A.I.M.E. at the University of Texas recently on the subject of "Practical Aspects of Bottom Hole Pressure Measurements."

L. P. TEAS, who recently resigned from the Humble Oil and Refining Company as chief geologist, has announced the opening of offices in the Commerce Building in Houston, Texas, for consulting work in petroleum geology and evaluation of oil and gas properties. JAMES I. RIDDLE resigned as chief scout for Humble the first week in January and is associated with Teas.

COLON W. MOORE, SR., general credit manager of Wickwire Spencer Steel Company and American Wire Fabrics Corporation, 80 Webster Street, Worcester, Massachusetts, was a visitor in the Mid-Continent area in December.

H. JENSEN, Jensen Petroleum Company, was elected president of the Chicago Oil Men's Club. Jensen's associates are J. G. PHINNEY, Cities Service Oil Company, vice-president; G. N. OLSON, George N. Olson Company, treasurer, and L. C. DENNING, Johnson Oil Refining Company, secretary.

B. P. SIBOLE, vice-president of the Stanolind Pipe Line Company, and P. A. BOHART, of the Gulf Refining Company, have been elected members of the Tulsa, Oklahoma, Chamber of Commerce.

E. O. BUCK, assistant director of production for District 3 of the Office of the Petroleum Coördinator, was in Washington, D. C., recently to confer with PCO heads on interpretation of new priority orders and full organization of the district offices.

GENE FISHER, assistant division engineer for Stanolind Oil and Gas Company at Fort Worth, Texas, is now filling a newly created position as production foreman at Odessa, Texas. A. R. BROWN, petroleum engineer, Brownfield, Texas, is being transferred to Fort Worth to succeed Fisher. W. M. ELIAS, petroleum engineer for Stanolind at Wink, Texas, is being transferred to Odessa. R. C. PUSEY, petroleum engineer at Odessa, will succeed Elias at Wink.

GILBERTO DELGADO, who received his degree in petroleum engineering from the University of Oklahoma in 1940, has completed practical field work with The Carter Oil Company and has returned to his home in Bogota, Colombia, South America.

BURDETTE BLUE, attorney and oil operator of Tulsa, Oklahoma, is now president of the Kansas-Oklahoma Division of the Mid-Continent Oil and Gas Association. Blue succeeds ROBERT S. KERR, Oklahoma City, elected first vice-president of the General Mid-Continent Oil and Gas Association.

JOHN FULLER, Oil Well Supply Company, Dallas, Texas, has been elected president of the Petroleum Engineer's Club of that city. He succeeds H. C. OTIS, Otis Pressure Control, Inc. Fuller's associates are HORACE SANDERS, Cooper-Bessemer Corporation, executive vice-president; W. W. SCOTT, Atlantic Refining Company, and R. E. LANDIS, National Supply Company, vice-presidents, and ED PETERS, Jones Drilling Company, secretary-treasurer.

J. D. COLLETT, Fort Worth, Texas, was renamed chairman of the board of the General Mid-Continent Oil and Gas Association at a two-day meeting of the association held in Tulsa, Oklahoma. All other officers of the association were renamed for another year: J. C. HUNTER, Abilene, Texas, president; ROBERT S. KERR, Oklahoma City, Oklahoma, first vice-president; FRANK O. PRIOR, Tulsa, vice-president for Oklahoma; RALPH PRYOR, Wichita, vice-president for Kansas; D. W. HARRIS, Shreveport, vice-president for Arkansas-Louisiana; VAN WELCH, Artesia, vice-president for New Mexico, and GEORGE SAWTELLE, Houston, vice-president for Texas.

HER MAJESTY . . . . *the* QUEEN

IN England, it isn't the person of the King that commands the allegiance of his people, but rather the things that the King represents. To British subjects the crown is not the halo of a man but the emblem of an empire. . . . In America we have no King but we do have a Queen—equally revered and equally rich in symbolism. . . . Her throne is a huge pedestal in New York harbor but her influence is a vital force in the lives and fortunes of every man, woman and child in America. Like the British King, she is sacred because of the things she represents—a form of Government and a way of life which have made us not only the wealthiest but, far more important, the happiest of nations. . . . It is to this Queen that oil men have pledged their genius and their resources. As part of the industry, Gaso considers it a privilege to join in her defense. . . . Gaso Pump & Burner Mfg. Co., 902 E. First Street, Tulsa, Okla. Export Office: 149 Broadway, New York. Houston: 5716 Buffalo Speedway. Los Angeles: Service Oil Field Supply Co., 5333 S. Riverside Drive.

GASO PUMPS
for every oil industry need

P. D. ELKINS, SR., has been promoted from section foreman for United Gas Pipe Line Company, Shreveport, Louisiana, to foreman of the Dallas, Texas, section. JOSEPH GOWAN, formerly an inspector on the Lirette-Mobile gas line, will fill the vacancy left by Elkins.

D. R. LOUCK, Wichita, Kansas, was reelected president of the Kansas Independent Oil and Gas Association. Other officers elected were JAMES DAVIS, JR., secretary, Wichita; JOHN HARWOOD, treasurer, Wichita; JOHN DENMAN, JR., Independence; RALPH NICHOLSON, Ellis, and F. G. STODDER, Wichita, vice-presidents.

R. STEINHORST is now assistant to the division engineer of The Texas Company at Tulsa, Oklahoma. His appointment became effective December 15. Steinhorst has been district engineer for the company at Wichita, Kansas. W. G. AUER of The Texas Company at Great Bend, Kansas, was transferred to Wichita to fill the vacancy left by Steinhorst.

JAMES NOEL was appointed by Attorney General GERALD C. MANN to direct the oil and gas division in the Attorney General's Department. Noel, who became associated with Mann in 1939, has been in charge of the department's land division. He succeeds EDGAR CALE.

JOHN STEIGER, formerly manager of the Mid-Continent news bureau of the *National Petroleum News*, is now editor of *The Empire*, official publication of the Cities Service Oil Company, Bartlesville, Oklahoma. Steiger's appointment was made by R. M. DAUGHERTY, manager of the public relations department of the company.

DR. HOWARD E. FRITZ, formerly manager of the synthetics division of The B. F. Goodrich Company, and one of the best known technical men in the rubber industry, has been named director of research by JOHN L. COLLYER, president of the company. Fritz has been with B. F. Goodrich Company since 1925. He succeeds JAMES W. SCHADE, research director since 1925, who has announced his retirement. Collyer also announced the appointment of WILLIAM S. RICHARDSON as general manager of mechanical goods and sundries sales. He succeeds J. H. CONNERS, who resigned because of ill health.

S. W. HOGAN, formerly production superintendent at Hutchinson, Kansas, for Transwestern Oil Company, has been transferred to San Antonio, Texas, by the company.

A. S. RHEA

A. S. RHEA has been named chairman for 1942 of the East Texas Section of the American Institute of Mining and Metallurgical Engineers. Rhea is an engineer for Sun Oil Company at Kilgore, Texas. Vice-chairmen are M. L. MAYFIELD, with the Operators' Committee at Cotton Valley, Louisiana, and C. B. CARPENTER, U. S. Bureau of Mines, Dallas, Texas. CURTIS F. MAXWELL, Humble Oil and Refining Company, Overton, Texas, was elected secretary-treasurer. E. H. BLUM, Atlantic Refining Company, Dallas; W. S. (BUCK) MORRIS, chairman of the East Texas Engineering Association, and E. L. RAWLINS, Union Producing Company, Shreveport, Louisiana, were named directors.

RALPH J. LUNDRIGAN is now with the Cochrane Corporation, Philadelphia, Pennsylvania, as supervisor of the merchandising of the new Cochrane-Becker high-pressure condensate return system.

JAMES A. LEWIS, Core Laboratories, Inc., Dallas, Texas, has been elected president of the Dallas Petroleum Geologists. DR. C. C. ALBRITTON, professor of geology of Southern Methodist University, was elected vice-president; BARNEY E. FISHER, of the Coronado Corporation, secretary, and FRED E. JOEKEL, Magnolia Petroleum Company, was elected a member of the executive committee.

H. B. BLOXOM of the sales staff of Fred E. Cooper, distributor of Allis-Chalmers Manufacturing Company, delivered an address before the Nomads Club of Tulsa, Oklahoma, on "Canada". Bloxom declared that oil field effort in Canada was increasing despite the severe handicaps of tax laws and predicted that Canada, especially in the Turner Valley area, would continue to increase output.

J. I. LAUDERMILK, formerly an instructor in petroleum engineering at the University of Texas, resigned to accept a captain's commission in the U. S. Army Air Corps. Laudermilk is now stationed at the Base Signal Office, Paine Field, Everett, Massachusetts, as assistant base signal officer.

GEORGE P. PASSMORE has been appointed works manager in charge of manufacturing of the Wellsville works by Worthington Pump and Machinery Corporation. Passmore was formerly manager of manufacturing of the South Philadelphia works of the Westinghouse Electric and Manufacturing Company and had been with that company for 20 years. He was given the Westinghouse Award of Merit for outstanding work in the manufacturing field in May, 1941.

THOMAS S. COOKE, 54, vice-president of Lago Oil and Transport Company and executive assistant of Aruba and Caripito refining operations, recently died of injuries received in an automobile accident. Cooke had completed 30 years' service with the company. During his long career one of Cooke's outstanding achievements was the location, design, and original construction of the large Lago refinery on the island of Aruba off the coast of Venezuela.

W. C. WREN, who has been division superintendent for the Osage district of the Mid-Continent Pipe Line Company, the transportation division of Mid-Continent Petroleum Corporation, has been made assistant general superintendent with offices in Tulsa, Oklahoma. He will be assistant to J. MARSTON LINEHAN, general superintendent. The announcement was made by GEORGE O. MOODY, vice-president and general manager of the Mid-Continent Pipe Line Company.

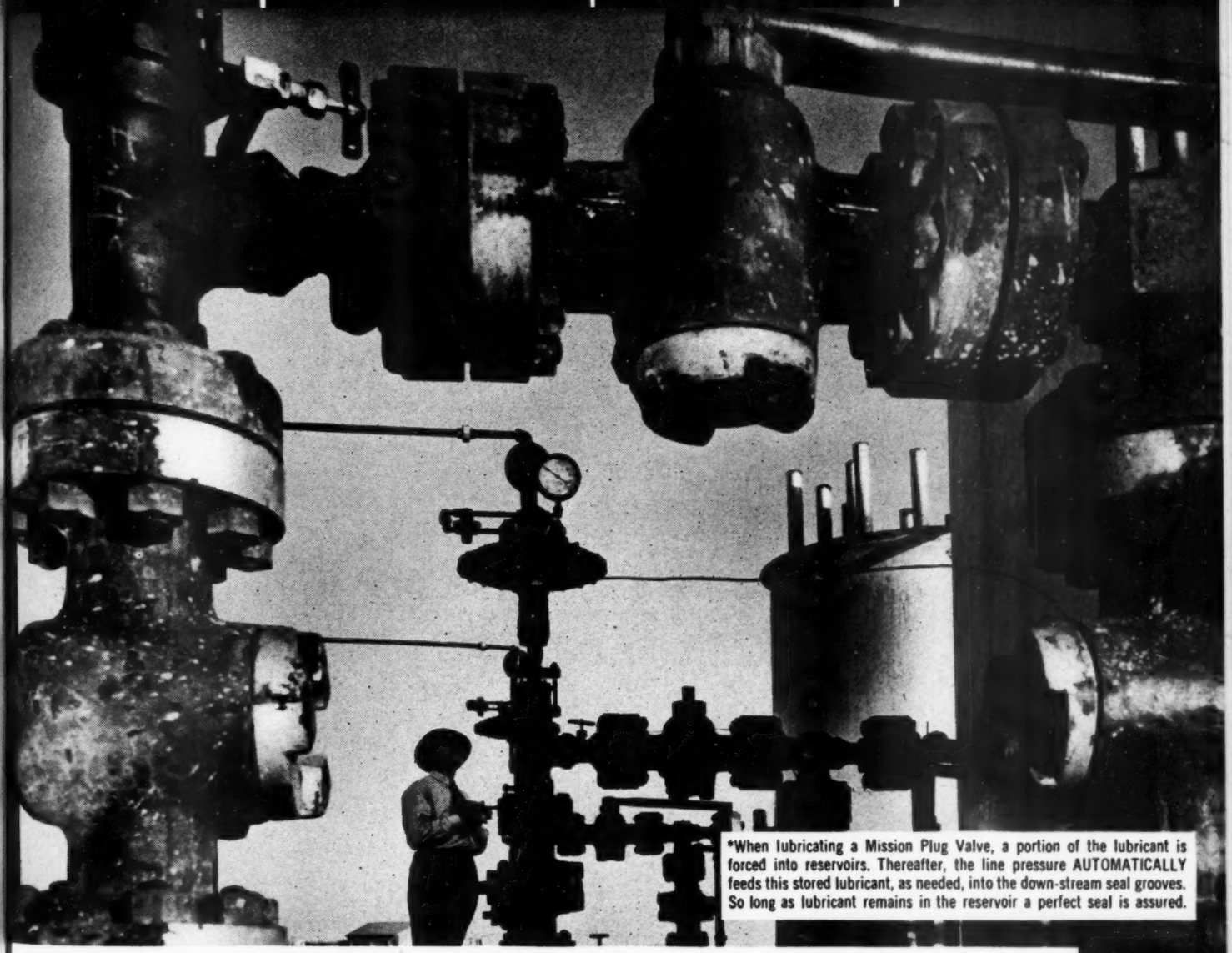
W. G. CORBITT

W. G. CORBITT has been placed in charge of the Wyoming Division of International Cementers, Inc., with headquarters at Casper. L. R. AUSTIN, formerly in charge of the Wyoming Division, has been transferred to Brownfield, Texas, where he will coöperate with Paul Lewis in the management of the West Texas Division of the company.

4 MISSION VALVE FEATURES

insure perfect sealing, easy turning and *longer* valve life

1. Automatic Lubrication.*	2. Full-Port Lubricant Sealing Grooves.	3. Wedge-Proof cylindrical Super-Surfaced Core.	4. Sealing Grooves on Plug never pass Ports.



*When lubricating a Mission Plug Valve, a portion of the lubricant is forced into reservoirs. Thereafter, the line pressure AUTOMATICALLY feeds this stored lubricant, as needed, into the down-stream seal grooves. So long as lubricant remains in the reservoir a perfect seal is assured.

1. **AUTOMATIC LUBRICATION**—Provides a constant lubricant seal • Line pressure automatically forces lubricant from reservoirs to sealing grooves • Eliminates necessity of frequent operation of lubricant screw • Ample downstream (sealing end) lubrication • Reduces friction — valve turns easily • Reduces wear and extends life of valve

2. **FULL-PORT SEALING GROOVES** — Sealing grooves encircle ports — assures complete uniform seal • Provides a dependable seal against high pressures, liquid or gas • Full-Port Lubrication thoroughly lubricates core—valve operates easily • Reduces washouts • Reduces wear and extends life of valve

3. **WEDGE-PROOF SUPER-SURFACED CORE**—Cylindrical Core positively cannot wedge—permits easy turning • Perfect fit of core to body conserves lubricant and maintains leakproof seal longer • Lubricant lasts longer . . . saves time . . . saves valves • Super-Surfaced core provides extra resistance to abrasives and corrosion agents • Reduces wear — lasts longer

4. **SEALING GROOVES ON CORE** — Never exposed to fluid • Prevent loss of lubricant into fluid line . . . insures constant seal • Protects sealing grooves on core from direct cutting action of fluid • Lessens intrusion of abrasives into lubricant sealing grooves . . . reduces wear on vital sealing surfaces • Prolongs life of valve

MISSION
MANUFACTURING CO.
HUMBLE ROAD • HOUSTON, TEXAS
EXPORT OFFICES: 30 ROCKEFELLER PLAZA, NEW YORK

MACHINERY and EQUIPMENT

Microphotometer

A RAPID and convenient method for analyzing spectrographic plates or films in research and industrial laboratories is provided by a new recording microphotometer announced

by Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania. Because the plates or films are mechanically scanned by a motor-driven Scanning Unit, and the relative positions and densities of spectrum lines are automatically recorded by an L&N Speedomax Recorder, this new recording microphotometer eliminates the eyestrain and "human equation" of visual methods, and does away with the delays and limitations of photographic processes, the manufacturer asserts. Quick determinations of elements present in small percentages are made possible by pen-and-ink records of standard and test spectrograms drawn at high speed on one chart.

Designed to accommodate plates or films as large as 4 in. high by 10 in. wide, the Scanning Unit includes on a heavy cast base, an optical system, a plate stage, a drive mechanism for the plate stage, an a-c. operated amplifier, and all necessary controls grouped at a convenient location. In indicating and recording relative positions and densities of spectrum lines, the response of the Speedomax recorder to density changes is so immediate and so rapid that in less than 1.5 seconds the pen moves from one position and comes to rest at its new position, even across the entire width of the 9-in. chart, it is asserted. Pen position can be read at a glance on an indicating scale as the record is being drawn. No unusual skills are required to operate this new microphotometer. Anyone familiar in a general way with instruments can quickly learn to use it.

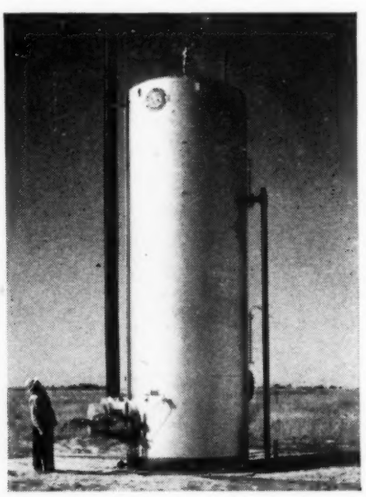
Family of Bail Bumpers

AN extensive series of Safety Swivel Bail Bumpers has been introduced by Patterson-Ballagh Corporation, Los Angeles, California. The line has been completed so that a swivel bumper is now available for every type of swivel on the market, it is stated. Special castings have been developed to fit each make of swivel. Each casting has a heavy-duty rubber bumper that can be replaced in the event of wear. These bumpers are bolted to the different types of swivel and the castings are contoured to fit the various shapes of swivels. Arrangements have been made by Patterson-Ballagh Corporation to distribute the bumpers both direct to swivel manufacturers for installation at the factories or for later installation in the field by operators.

Three-Stage Treating Unit

WITH a new and simple design that embodies all the principles necessary for a successful single unit treating system, Black, Sivalls and Bryson, Inc., Oklahoma City, Oklahoma, offer a new three-stage treating unit as the most recent development in the BS&B line of emulsion heating and treating equipment. The single unit provides the following essentials:

1. Means of removing all free gas entering the system and all gas forced out of solution by heating. Removal of this gas must be accomplished *before* the settling section is reached.
2. A *quiet* settling section of adequate volume.
3. A high-capacity heating element that may be removed easily.
4. An effective free water knockout to prevent overloading the heating element.
5. A maximum length of emulsion travel through hot wash water.
6. Temperature control that is entirely automatic.



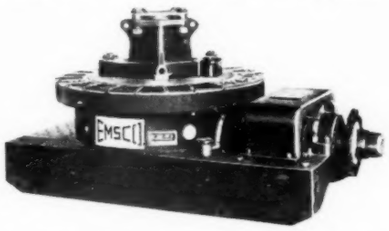
In three distinct steps the BS&B Three-Stage Treating Unit strips off free water and free gas in a separate free water knockout and gas separating

flume; separates all gas liberated from the oil and emulsion by application of heat before the settling action is reached, and settles out the last small percentage of water from the oil before it leaves the treating unit. The BS&B temperature controller provides automatic operation of the heating element for uniformity of treating temperature.

An important feature is that the cool gas released in the first stage is mixed with the warm gas from four points in the second and third stages, thus cooling the outlet gas and condensing the lighter fractions of the oil. The condensed fractions drop back into the settling section. There is a common blanket of gas over all the flumes and receptacles in this three-stage treating unit. The cool gas, first liberated as the inflow enters the vessel, cools the gases rising from the other compartments.

Rotary Table

THE Emsco JCS-20½-in. Rotary Table recently designed by Emsco Derrick and Equipment Company, Los Angeles, California, introduces a pin drive kelly bushing. The top of the table has two large-diameter holes cored and machined into it on opposite



sides of the bushing square. The holes are bushed with rubber sleeves to absorb shock. The kelly bushing has two replaceable pins projecting from it to coincide with the holes in the table top. An easily latched locking device is also part of the assembly. The pins are large diameter and fit easily into the corresponding holes in the top of the table to make a very substantial driving medium. A long skirt projects below the bushing to act as a guide in centering it into the taper of the master bushing. The master bushing for this new table has an extremely long taper to give full support to the long back slips. The kelly bushing rests on top of the table and thus has absolutely no contact with the master bushing.

The kelly bushings are of two types: (1) the Emsco Baash-Ross Roller Type and (2) the Emsco Slip Type having hardened inserts. The base is of all-welded steel construction and the table is made with a recessed table guard and cone rollers for the main bearing.

You Can Take Both

Bottom Hole Pressures in 2-Zone Production

by using an OTIS Type G (SIDE DOOR) BOTTOM HOLE CHOKE

This is no time for guessing. Accurate knowledge of *Bottom Hole Pressures* is necessary for efficient and economical producing operations.

The Otis Type G Choke provides a means to take the bottom hole pressure of either the upper or lower zone independently of the other.

The Type G Landing Nipple, which is made up in the tubing string, has four ½-inch holes through its walls, permitting flow from the casing annulus into the tubing. The Type G Choke seats and locks in the landing nipple and provides complete control of the entrance of fluid into the tubing string from either or both pays. By using a blank cup mandrel on the Type G Choke, the side ports in the landing nipple can be blanked off, permitting flow into the tubing from the lower pay only. This condition permits the bottom hole pressure to be taken of the lower zone. To reverse these conditions, so bottom hole pressures can be taken of the upper zone, a perforated cup mandrel with its lower end plugged is used on the same Type G Choke. This combination shuts off the lower zone and permits only the upper zone to flow into the tubing.

The running and pulling of the Type G Choke can be done under pressure, usually requiring only a few hours. The same steel measuring line used to run and pull the bottom hole pressure instrument can be used to run and pull the Type G Choke.

The Type G Choke also is a valuable aid in completing two zone producers. Its use permits setting the packer and permanently hooking-up and tying-down the tubing connections before the well is brought in. The two pays can be brought in without moving the tubing or affecting the packer seal.

In the event the annular space "loads-up," the Type G Choke provides a means to kick-off the accumulated "head" and to start the upper zone to flowing again.

Consult your nearest Otis representative . . . he will be glad to help you on any pressure problem.

Write for complete information and details

OTIS PRESSURE CONTROL, INC.

DALLAS, TEXAS

PRESSURE CONTROL OTIS SERVICE - EQUIPMENT

Branches: Houston, Texas; Hobbs, New Mexico; New Iberia, Louisiana

Representatives: Otis Eastern Service, Inc., Wellsville, New York; Western Pressure Control, Inc., Los Angeles, California

Export Office: 74 Trinity Place, New York City

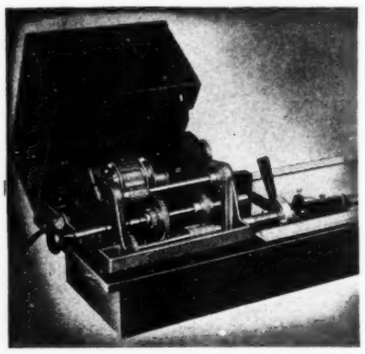
Ductility Machine

PRESENTING several new and exclusive features, the new ductility machine announced by the Precision Scientific Company, 1750 North Springfield Avenue, Chicago, Illinois, complies with Designation D-113 of the American Society for Testing Materials, for testing the ductility of bituminous materials at speeds of ¼, 1, or 5 cm. per min.

Having a depth of 5 in., ample room is allowed for insertion of cooling coils or ice when conducting tests at reduced temperatures.

The selective gear-drive mechanism, fully enclosed in a metal housing, is of the automotive type, with all gears of bronze, on steel shafts. Bearings are oilless type, requiring no lubrication. Speed selection is virtually instantaneous, by means of gear-shift lever protruding from the gear-drive housing.

Ruggedness, coupled with accuracy, is achieved by utilizing a bronze lead screw, with Acme square threads free from sharp peaks, to avoid screw thread delicacy. A single lead screw, instead of two found in other machines, occupies little space in the trough, and is above the water level so that agitation of the water, likely to impair observation of the breaking point of the sample, *does not occur*. Being freely mounted at both ends,



the lead screw is not subject to binding or cramping stresses that would effect uniformity of pulling speed.

After the carriage reaches the 150 cm. limit, it automatically disengages the lead screw, and comes to rest.

Perfectly smooth travel of the carriage to insure constancy of pulling speed, is attained by the use of bakelite shoes riding against a pair of polished brass slides.

A clutch engages or disengages the lead screw, controlled by the quick, simple movement of a hand lever. With the clutch disengaged, the cross slide can be manually shifted back to starting position, the operation taking just a few seconds.

Readings can be taken as high as 150 cm. The scale is divided in centimeters and millimeters, and the indicating pointer adjustable, so that it can be set to the exact zero position at the starting point.

The machine can be suspended in a table top for flush mounting, often desirable; or can be suspended in a tank for circulating liquid to maintain constant temperature.

Black-Out Paint

A BLACK-OUT paint for use in darkening windows and skylights of industrial and commercial properties where it would be impractical to extinguish lights at the sound of an air-raid warning, has been announced by American-Marietta Company, 43 East Ohio Street, Chicago, Illinois.

The paint had been undergoing development in the company's laboratories for several months with the thought that it might, at some future date, find application in some outlying United States possessions. Final tests were speeded with the Japanese attack on United States possessions in the

Why is Directional Cooling So Important?

It is so important because the coolest water is directed first against each valve seat and maintains lower temperatures at these vital points.

This increases the life of valves — keeps engines running more efficiently and saves on repairs.

Other important features in Red Seal Continental Engines for oil field service are — full length water jackets — packless, sealed-type, ball bearing water pump — interchangeable bearings — counterweighted crankshaft with precise balancing — pressure lubricated barrel-type tappets—and individual porting for quick starting, maximum power, economy, and flexibility.

Sales and Service Facilities

Dallas: National Welding & Grinding Co. Longview: Standard Tool & Machine Co.
Houston: C. Jim Stewart & Stevenson Co. Wichita Falls: Wichtex Machinery Co.

Continental Motors Corporation
MUSKEGON, MICHIGAN

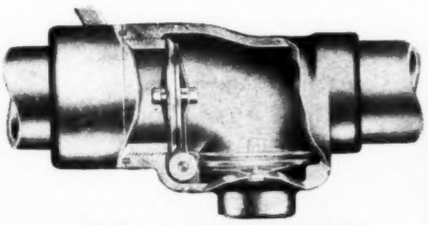
Pacific, and commercial production began ten days later. First shipments were made to distributors on the Pacific, Atlantic, and Gulf Coasts.

The paint is being marketed in paste form, and, when cut 50 percent with water, can be sprayed or brushed on windows to prevent all passage of light. Coverage is 800 sq. ft. to the gal. It dries within 40 minutes, providing a flat surface that will not flash back or glare when hit by artificial light used within the room. In interior applications, a single coat may be covered with a white paint when large glass surfaces make the higher reflection properties of a white surface necessary.

Removal of the product, termed Valdura Black-Out, is made without damage to the glass. It is being packed in 1- and 5-gal. containers.

Compounding Valve

THE American Slush Pump Compounding Valve, manufactured by the American Iron and Machine Works Company, Oklahoma City, Oklahoma, is said to speed-up the compounding

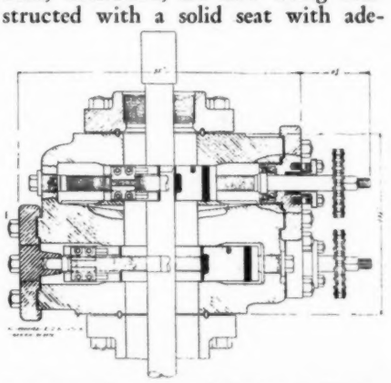


American Iron Compounding Valve

of slush pumps. A movement of one lever and pumps are in compound. It has a removable valve and seat that can be renewed quickly on location. These valves have been used extensively in high-pressure areas, it is stated.

Cellar Control Gates

ALL cellar control gates manufactured by Shaffer Tool Works, Brea, California, are now being constructed with a solid seat with ade-



quate sand and mud drainage feature below the sealing surface. This applies to all types whether equipped with self-centering rams for closing around pipe or with rams for complete shutoff.

As shown in the illustration, this feature is incorporated in the double cellar control gates, one of the most recent developments in this line of equipment. This gate has been designed for use where the vertical space available is so small that it is desirable to reduce even the very small space required for two single gates and the connecting spool between. The two ram compartments comprising the double cellar control gates are modeled after the Type 34 gates with the upper compartment having rams to close around the pipe and the lower compartment equipped with rams for a complete shut-off when the pipe is out of the hole.

The vertical space required by the double cellar control gates is approximately half that required for two single gates and their connecting spool. The double gate itself is less in height than two single gates. When it is desired to eliminate the space required by a mud cross below the double gate this gate can be supplied with two 2-in. outlets in the body of the gate below the rams in the lower compartment to serve as a mud cross. These outlets are used to connect with fill-up lines and for relieving pressure when the gate rams are closed.

Make Your Jobs *MOVE*

—with "CLEVELANDS"

Their modern, job proven design puts more dirt off the conveyor. Their super-quality construction makes them keep doing that. From every angle—power, speed, durability—ease of handling and portability—"CLEVELANDS" have proven themselves, on the job, pipeline performers of a superior type.

PRODUCTS:—Ditchers, Wheel and Ladder Type (in several models)—Side Boom Backfillers and Pipe Cranes, etc.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE. "Pioneer of the Small Trencher" CLEVELAND, OHIO
"CLEVELANDS" Save More . . . Because they Do More

"Gloweld" Tubing

STAINLESS STEEL tubing produced by a closely controlled electric welding process is now ready for production by Globe Steel Tubes Company, Milwaukee, Wisconsin. Developed after a long period of research and experiment with various welding processes, this new welded stainless steel tubing provides a high degree of corrosion resistance, strength with minimum weight, and uniformity of structure, according to Dr. H. K. Ihrig, director of laboratories of Globe Steel Tubes Company.

The method of welding the stainless strip is said to result in a tube with very little "flash," thereby reducing to a minimum the amount of grinding or cutting-off of flash required to obtain a smooth finished tube. The structure of the weld metal very closely approximates the structure of the tube itself. The new tubing can be readily bent, coiled, swaged, and formed.

Welded stainless steel tubing will be marketed under the trade name of "Gloweld."

Gloweld will soon be available in a wide range of diameters and wall sizes and in practically all the stainless steel analyses, it is stated by the manufacturer.

Globe Steel Tubes Company has adopted Gloweld after a long period of research and experiment, drawing upon its many years of experience as a manufacturer of stainless steel tubing.

First Aid Kit

A completely weatherproof first aid kit, known as the Bullard Weatherproof, is now available with a mounting bracket that permits the kit to be removed instantly and carried to the injured when necessary. It mounts to the wall or post in such a way that when the lid is opened it acts as a shelf for the treatment being used.

Contents are protected from the weather by a special "weather-strip" rubber tube that also acts as a spring that opens the lid when the fastener is released. Contents are easily removed whether the kit is laying flat or is wall mounted because the sides are lower than the individual packets of treatments, which provides plenty of finger room.

Inside the lid of each kit is an "Instant Guide to First Aid," which gives the user application instructions and injury diagnosis symptoms. Ask for the folder: "A Unit First Aid Plan." Manufactured by E. D. Bullard Company, 275 Eighth Street, San Francisco, California.

Wire-Rope Electric Hoist

THE SPEEDWAY, a new lightweight, compact, wire-rope electric hoist has been added to their present line by the Wright Manufacturing Division of the American Chain and Cable Company, Inc., York, Pennsylvania.

The Speedway is obtainable in capacities from 250 to 1000 lb. Portability, flexibility, and accessibility are outstanding features of this hoist. Like any electrical accessory, it is ready to go to work anywhere; just plug in on a lighting circuit, or use with conductor systems.

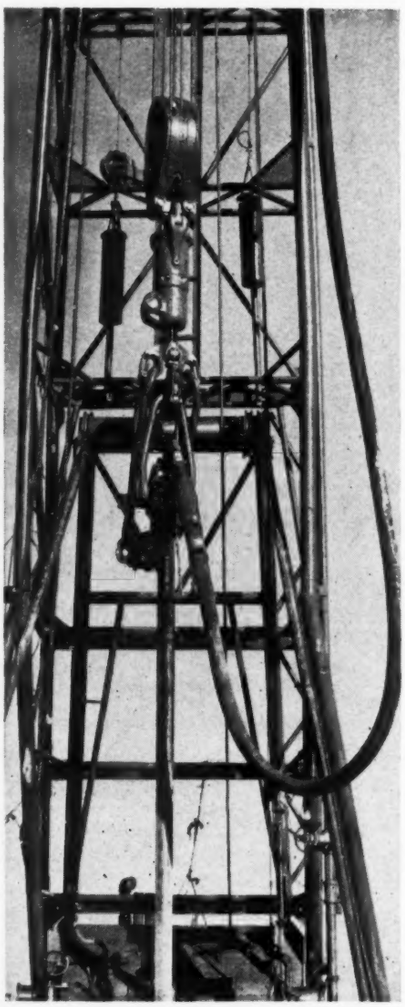
Outstanding features of Speedway construction, according to the manufacturer, are push button control, weather-proof, acid-proof, dust-proof, preformed hoisting cable on drum winding, eliminating slack chain fouling loads, safety limit switches, safety load blocks.

The equipment is supplied for lug, hook, or trolley suspension and can be mounted parallel or crosswise to runway beam when used with trolley.

It is supplied for 110- or 220-volt, single-phase, 60-cycle current; also for 220- or 440-volt, 3-phase, 60-cycle.

Details will be supplied on request.

McKISSICK
Streamlined Blocks for Streamlined Drilling Rigs



This compact, sturdy built block assures maximum working space in the derrick. It is extremely well balanced for straight fall and safety.

The McKissick Traveling Block has a large diameter center pin for strength and long bearing life... 30" Alloy steel sheaves with A.P.I. grooves, heat treated for maximum sheave and wire line wear... Hy-Load Roller Bearings with Alemite Lubrication... Short Overall Length... 100 Ton Capacity with ample safety factor.

It can be furnished with adapter which can be connected to drilling hook with short rigid coupling.

Write for Illustrated Bulletin

McKISSICK PRODUCTS CORP.
TULSA, OKLAHOMA

New Valve and Meter Offices on West Coast

Because of expanded activities, Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company have opened new sales offices in San Francisco, California, and Seattle, Washington. This is in line with a plan of increased sales and service facilities for the entire west coast, according to Captain A. E. Higgins, vice-president. Russ Waters has been appointed branch manager of the new San Francisco office, in the Hobart Building, 582 Market Street. Waters will be assisted by Fred D. Webster, Richard L. Ford, and Gilbert T. Bowman in covering the area of northern California and Nevada.

The new Seattle office at 119 West Denny Way, will serve the states of Oregon, Washington, and Idaho, under the jurisdiction of the San Francisco branch. Frank P. Tangney will be in charge of water meter sales in general in that area and William R. Dominick will cover industrial sales.

Hereafter, sales activities in the Bay District will be directed from the San Francisco office instead of from the companies' plant at Oakland. H. Boezinger, vice-president, is in charge of all sales activities for the entire west coast.

Hyatt Celebrates Fiftieth Anniversary

With the year 1942 scheduled to be the busiest in its entire history, the Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey, reaches its 50th anniversary.

Back in 1892 when John Wesley Hyatt, one of America's foremost inventors (father of the plastics industry through his previous invention of celluloid), established the Hyatt Roller Bearing Company, American industry was running chiefly on axle grease and plain bearings. His invention of the roller bearing and later developments by other anti-friction bearing builders ushered in a new machine age with all wheels and shafts of industry turning smoothly and economically on modern bearings today.

Likewise, are planes, tanks, guns, and ships and other mechanized fighting equipment fully anti-friction bearing equipped.

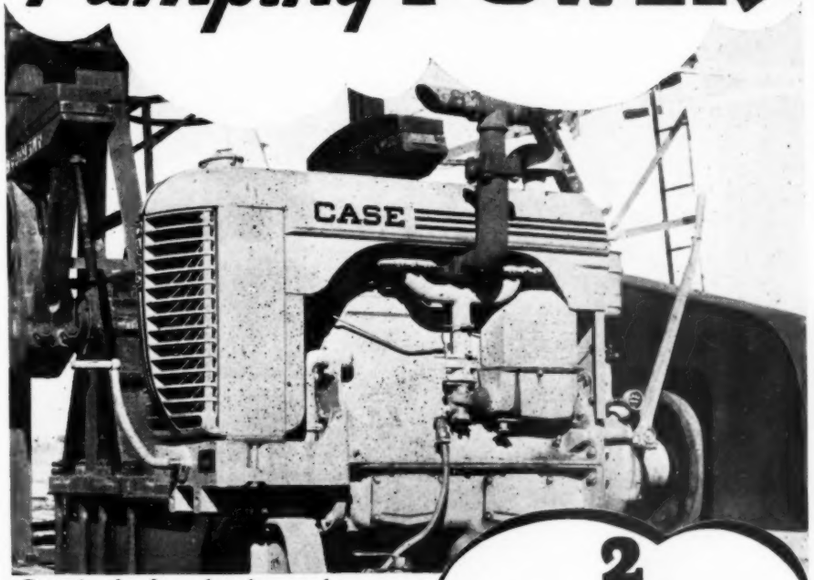
Alfred P. Sloan, Jr., whose first job out of college was as a Hyatt draftsman, rose to its presidency and guided the firm through its major period of development. This coincided with the inception and growth of the automobile industry whose products more than any other have depended upon anti-friction bearings for speed and stamina. Under Sloan's leadership the Hyatt company was brought early into the General Motors group of which Sloan now serves as chairman of the board.

During its half century of sound growth from a one-man machine shop to its present vital position in American industry and armament, Hyatt contributed to many other major advancements in addition to the motor car, including such industries as petroleum, mining, railroading, agriculture, textile, and aviation.

Hyatt bearings developed from a crude assembly of wound steel rollers that originally incorporated the principle of flexibility, in order to take up discrepancies of the 19th century wide tolerances, to a precision solid roller type of bearing that is held to microscopic tolerances of less than 0.0001 inch in quantity production.

The big Hyatt plant in New Jersey, a familiar landmark to Pennsylvania Railroad travelers approaching New York, is celebrating its Golden Anniversary this year by working three shifts day and night under General Manager H. O. K. Meister, building millions of Hyatt Roller Bearings needed for the American victory.

LONG RANGE *Pumping* POWER



2 Brand-New Models

The farther ahead you plan your pumping program . . . the farther away you want to keep from frequent attendance . . . the farther down you must pare your operating and upkeep costs, the more you will like the endurance and self-protection built into the new 35 H.P. "DE" and 55 H.P. "LAE" Case oilfield engines.

Pressure-oiled governor and clutch, four-ring pistons, self-sealing water pumps run longer before needing attention. Automatic cut-outs act if engine temperature goes up or oil pressure goes down, guard against damage by mishap or neglect. Ask distributor for details. J. I. Case Co., Racine, Wis.

DISTRIBUTORS
Southwest Equipment Co.
Dallas and Kilgore, Texas
Leland Equipment Co.
Tulsa, Oklahoma

CASE
Oil Field Engines

Wickwire Spencer Steel Company Announces Promotions

E. C. Bowers, president of the Wickwire Spencer Steel Company, announces the election of Dean Rollans as vice-president in charge of sales, and the appointment of William H. Husted as assistant to the president. In addition to his duties as assistant to the president, Husted will be given leave of absence for three days a week to serve as consultant to the Raw Materials Division, Iron and Steel Unit of OPM.

Rollans, who was educated at the University of Arkansas, entered the steel business in 1921 with the International Supply Company of Tulsa, Oklahoma, steel and oil-well suppliers. In 1928, he became district credit manager and wire rope sales representative in Tulsa for Wickwire Spencer Steel Company, a position he held until he was transferred to the company's Worcester, Massachusetts, office in 1930. He remained in Worcester until this year when he was transferred to the company's headquarters in New York as general sales manager. He is a member of the Wire Products Subcommittee of the Iron and Steel Defense Advisory Committee to the OPM.

Husted, a graduate of Yale University, was formerly associated with the United States Aeromotive Corporation. He studied aviation at the Embry-Riddle Aviation School, Miami, Florida, and earlier this year joined Wickwire Spencer Steel Company.

"Low upkeep cost" is not enough!

Throughout the oil fields, Twin Disc Heavy-Duty Clutches and Power Take-offs are recognized for their low upkeep costs . . . that's one reason why better than 9 out of 10 builders of oil field equipment continue to standardize on Twin Disc Clutches.

But the Twin Disc Clutch Company does not take full advantage of this situation . . . they protect these manufacturers by maintaining adequate parts stations throughout the oil fields, in addition to factory branches at Dallas, Tulsa and St. Louis. Thus you are doubly protected — *first*, by a clutch whose long life and low maintenance is a matter of record; *second*, by quickly available parts and service should occasion demand them. TWIN DISC CLUTCH COMPANY, 1329 Racine St., Racine, Wisconsin.

AT LEFT: *Twin Disc Model E Clutch, heavy-duty, enclosed type. Sizes: 14" to 42" in single or two-plate assemblies.*

BELOW: *Twin Disc Power Take-off for engines having up to 285 hp. output. Sizes: with single plate clutches, 6½" to 24"; double plate, 11½" to 18". Housing sizes: No. 6 S.A.E. to No. 00 S.A.E.*

Duncan Succeeds Campbell for Waukesha Motor Company

George A. Duncan, for the last 8 years assistant branch manager for the Waukesha Motor Company at Tulsa, Oklahoma, has been advanced to the position of manager, succeeding Arch F. Campbell, who resigned to become manager of sales for the Superior Engine Division of The National Supply Company.

GEORGE A. DUNCAN

Duncan entered the oil industry more than 15 years ago with the Barnsdall Oil Company in Tulsa. Later he entered the machinery business with the C. F. Camp Company of Tulsa, one of the pioneers in this type of business, and as distributors for the Waukesha Motor Company they were instrumental in the development of the internal-combustion engine for drilling.

A direct company branch was established in 1933 and Duncan joined Campbell's staff as assistant branch manager in September of that year.

Oklahoma Utilities Association Elects Officers

At a meeting of the board of directors of the Oklahoma Utilities Association held in Tulsa, Oklahoma, officers and directors for the year 1942 were elected. The convention chairman and committee were also appointed for the 1942 Oklahoma Utilities Association Convention, which is to be held March 23 and 24 in Oklahoma City at the Oklahoma Biltmore Hotel.

The 1942 officers are: President, W. L. Woodward, president, Zenith Gas System, Inc., Alva, Oklahoma; first vice-president, J. C. Happenny, presi-

dent, Oklahoma Power and Water Company, Sand Springs, Oklahoma; second vice-president, E. C. Joullian, president, Consolidated Gas Utilities Corporation, Oklahoma City, Oklahoma; treasurer, B. M. Lester, vice-president and treasurer, Oklahoma Gas and Electric Company, Oklahoma City, Oklahoma, and secretary, Miss Kate A. Niblack, Oklahoma Utilities Association, 626 Biltmore Hotel, Oklahoma City, Oklahoma.

SKF Employees Awarded Navy "E" Pennant

More than 4200 employees of SKF Industries, Inc., Philadelphia, Pennsylvania, won the Bureau of Naval Ordnance Flag and the Navy "E" Pennant

for excellence of performance in fulfilling naval ordnance contracts for ball and roller bearings. Rear Admiral A. E. Watson made the presentation, and William L. Batt, SKF president, gave the acceptance speech.

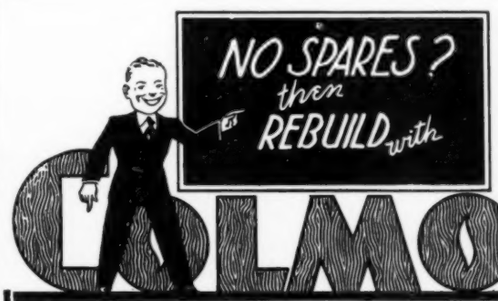
Dr. Frolich Elected Head Chemical Society for 1943

Dr. Per K. Frolich, director of the Chemical Division, Esso Laboratories of the Standard Oil Development Company, Elizabeth, New Jersey, and internationally known for his work in the development of synthetic rubber, has been elected president of the American Chemical Society for 1943. Dr. Frolich took office as president-elect on January 1, 1942, when Dr. Henry N. Holmes, head of the department of chemistry at Oberlin College, became president, succeeding Professor William Lloyd Evans, head of the department of chemistry at Ohio State University.

The new president-elect was chosen by the Society's Council from four nominees receiving the largest number of votes in a national mail ballot of the Society's 29,000 members. The Council includes national officers, directors, editors of the Society's publications, past presidents, chairmen of 18 professional divisions, councilors from the Society's 94 local sections, and councilors-at-large.

Professor Arthur J. Hill of Yale University and Dr. E. R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania, were chosen directors. Dr. Charles Allen Thomas, director of the Thomas and Hochwalt Laboratories, Dayton, Ohio, research division of the Monsanto Chemical Company, was named director-at-large.

New councilors-at-large are: Dr. George D. Beal, assistant director of the Mellon Institute of Industrial Research; Dr. Gustav Egloff, director of research of Universal Oil Products Company, Chicago, Illinois; Professor Henry Gilman of Iowa State College, and Professor Carl S. Marvel of the University of Illinois.



COLMONOY

Remember when you could call up in the morning and have a replacement part delivered in the afternoon?

Now it's quicker—cheaper—to hard-surface all wearing parts with COLMONOY.

Equipment that must take a lot of punishment—perhaps for 24 hours a day—will operate efficiently, with less wear, when the proper grade of COLMONY is used as a hard-facing for all parts subject to excessive abrasion and corrosion. It will pay you to investigate.

In Pumping Hot Oil — at 900° F.

— a recent check-up of a COLMONOY coated pump sleeve showed that this sleeve ran 2400 work hours, as compared with other hard-surfaced sleeves at 360 work hours.

The pump, running at 3600 R.P.M., handled hot oil at 900° F.

Such resistance to corrosion and abrasion is just another reason why you should investigate the application of COLMONOY on your tough jobs.

WRITE FOR CATALOG

Our engineers will be glad to discuss the proper application of COLMONOY to meet your individual requirements. Your letter will receive prompt attention.

WALL-COLMONOY CORP.

Sixth Floor, Buhl Building, Detroit, Michigan

558 W. 54th St. NEW YORK
208 Midco Building TULSA
625 W. Jackson Blvd. CHICAGO
21 Seneca St., BLASDELL, N. Y.
123 W. Philadelphia St. WHITTIER, CALIF.

COLMONOY

Hard Surfacing Alloys and Overlay Metals

"Weco" Purchases Boiler Equipment Supply Co.

Well Equipment Manufacturing Corporation, worldwide distributors of the patented Thompson fusible plugs and steam gauge protectors, announces the purchase of the physical assets of Boiler Equipment Supply Company, of Oklahoma City, Oklahoma, following the recent death of Lester O. Thompson, Boiler Equipment Supply Company owner. All shop equipment has been moved to the "Weco" plant in Houston, where these products will be manufactured for exclusive supply store distribution.

Kesselman Appointed Fluid Packed Pump Advertising Manager

Lyle E. Kesselman, for the last six years Fluid Packed Pump Company's field representative in the Los Angeles Basin District, has been advanced to the post of advertising manager and head of the Foreign Sales Department, according to announcement by company officials.

Kesselman is widely known among oil men. He first went to California late in 1920 to establish a branch plant for Kesselman and Company of Butler, Pennsylvania, and Parkersburg, West Virginia. After the Santa Fe Springs activity in 1925, Kesselman

LYLE E. KESSELMAN

entered the drilling and production phases of the oil business and has continued active in all lines since.

Brock Manager Industrial Relations for Roebling

BERT M. BROCK

Bert M. Brock has been appointed manager of industrial relations for the John A. Roebling's Sons Company, Trenton, New Jersey.

Announcement of Brock's appointment, effective January 1, was made by C. G. Williams, executive vice-president of the company.

Brock for the last year has been director of industrial relations, Pittsburgh District, Carnegie Illinois Steel Corporation, and prior to that was assistant director of industrial relations for the U. S. Steel Corporation of Delaware, Pittsburgh, Pennsylvania. Previously, he was manager of industrial relations for the Columbia Steel Company at San Francisco.

F. M. Young Honored

F. M. Young, president and founder of Young Radiator Company, Racine, Wisconsin, was elected an honorary member of Alpha Chapter of Pi Tau Sigma, honorary mechanical fraternity, at a formal initiation ceremony and banquet held at Memorial Union Building, University of Wisconsin, Madison, Wisconsin, recently.

The Plunger Is The Heart of Your Pump

And Only Martin Plungers Have the One-Piece "Fluid-Proof" Bodies and "Compensated" Precision Packing Rings

To reduce tube wear to a minimum; to cut the number of pulling jobs and repair bills on pumps —get Martin Plungers. These plungers have a one-piece, grooved body with split packing rings made of special resilient rubber and fabric. These rings contact the tube, effectively resist sand and other abrasives, and are lubricated at all times—even when pumping salt water—since water lubricates rubber.

Martin rings are easy to change, and are supported by the metal lands of the plunger. Longer plungers, with more rings, take care of increased pressures. Since the bodies are made smaller than the tube and do not work against the tube, they can be used again and again.

Write for Illustrated Catalog, or See Composite Catalog

SOLD ONLY THROUGH SUPPLY STORES

3¾"x36 Groove Martin Plunger Body Without Rings.

Hundreds of Operators are Making a Handsome Profit Today by Using Martin Plungers

Field Representatives

TOM HULETT, El Dorado, Ark.
C. J. BAETEN, Wichita, Kans.
LYNN C. HOLLOWAY, Houston, Texas
J. WALTER WADE, Olney, Ill.
HUGH ROBINSON, Blackwell, Okla.
E. M. SCAGGS, Longview, Texas
F. M. WILSON, Wichita Falls, Texas
J. B. ALEXANDER, Odessa, Texas
E. C. DILGARDE, Casper, Wyoming

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Young was honored by the fraternity in recognition of having "done much to advance the profession and to encourage young men to do likewise." Each year the fraternity chapter selects one or two outstanding mechanical engineers who have, in addition to the above qualifications, also "attained the goal to which they aspire."

R. J. Woods, Jr., District Sales Manager for J & L

The appointment of R. J. Woods, Jr., as district sales manager and the creation of a new district sales office in Tulsa, Oklahoma, has been announced by the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. The importance of the Tulsa territory prompted the company to change Tulsa from a sub-office of the Memphis District, which it has been since May, 1940, to a full district sales office, it was said.

R. J. WOODS, Jr.

Woods has been a sales engineer in the Memphis District office since 1935 and prior to that had been with the Wilson Weesner Wilkinson Company in Nashville and Knoxville, Tennessee, and Atlanta, Georgia, in a similar capacity. He was graduated from Vanderbilt University in 1928.

Other changes involving J & L district sales offices and managers include the appointment of John B. DeWolf, formerly district sales manager in New York, New York, as district sales manager in Washington, D. C.; the appointment of S. A. Fuller, formerly district sales manager in Chicago, Illinois, as district sales manager in New York, to succeed DeWolf; the appointment of Earnest W. Harwell, formerly district sales manager in Memphis, Tennessee, as district sales manager in Chicago to succeed Fuller, and the appointment of E. E. Hoehle, formerly assistant district sales manager in Memphis, as district sales manager in that city to succeed Harwell.

Falk Appoints Advertising Manager

The Falk Corporation, Milwaukee, Wisconsin, announces the appointment of Ralph H. Deihl to the position of advertising manager. Deihl was graduated from the Commerce School of the University of Wisconsin in 1936 and spent two years in the advertising department of the Bucyrus-Erie Company and two years in the advertising department of the National Enameling and Stamping Company, both in Milwaukee. He joined the Falk Corporation in May, 1940, and has been handling the advertising of the company since that time.

Dresser Acquires Bovaird and Seyfang

Dresser Manufacturing Company, Bradford, Pennsylvania, has announced the acquisition of Bovaird and Seyfang Manufacturing Company of Bradford, as a wholly-owned subsidiary. The motive in acquiring Bovaird and Seyfang was to obtain additional manufacturing capacity for Clark Bros. Co. of Olean, New York, a Dresser subsidiary. Bovaird and Seyfang has 147,000 sq. ft. of plant and building space, equipped with heavy machine tools, a boiler shop, and grey iron foundry, all of which are useful adjuncts that should enable Clark Bros. Co. not only to speed delivery of engines to the Maritime Commission but also to accept any additional business that may be available in its own field—the oil and gas industry.

A million feet of casing *protected* without a failure

A RECORD IN ONE OF THE DEEPEST FIELDS IN TEXAS

In this field 110 wells have been drilled during the past five years.

Average depth of the wells is 10,500 feet. None has been drilled less than 10,000 feet.

Only the heaviest and finest equipment is used in this Texas field. Patterson-Ballagh Products are used extensively.

There has been but one fishing job in the field, caused by a casing protector. (Not a Patterson-Ballagh Protector.)

There has been no collapsed pipe in the entire field. Patterson-Ballagh Protectors have helped avoid collapsation.

Drill pipe has shown extreme life. Some strings are still in service after five years with the same tool joints, where protected with casing protectors.

Patterson-Ballagh Casing Protectors were used on all wells except two, of which one was a string of rented drill pipe sent to the field to complete a well.

The casing of all wells now drilling is protected with Patterson-Ballagh Protectors and all use Patterson-Ballagh fitted Kelly Subs.

No casing trouble has been experienced. Almost 800,000 feet of water string has been set and more than 240,000 feet of larger casing. This makes a total of more than one million feet of casing protected by Patterson-Ballagh Protectors without a failure. That's a record!

PATTERSON-BALLAGH Corporation

LOS ANGELES HOUSTON NEW YORK CITY

PATTERSON-BALLAGH

Drill Pipe and Casing

PROTECTORS

with lips

Earl Rives Joins Wallace Davis and Company

Earl Rives resigned from Reed Roller Bit Company, effective January 1, to become associated with Wallace DavisandCompany, specialized oil industry advertising agency of Houston, Texas.

EARL RIVES

In his new connection, Rives will serve as an account executive and will spend considerable time in the oil fields assembling performance data on equipment.

Rives attended Texas Lutheran College and the University of Texas, and subsequently spent two years in commercial photography. He joined the Advertising Department of Reed Roller Bit Company approximately four years ago, and for the last two years has served as assistant advertising manager.

E. H. Poe on Trip

E. Holley Poe, New York City, secretary, Natural Gas Section, American Gas Association, recently made a business trip through the Mid-Continent and Gulf Coast areas and to New Orleans, Louisiana, where the association is to hold its annual convention in May.

Eliminates Whipping
Prevents Crawling
Prevents Overlapping
Minimizes Wear
Prevents Damaging Lines
Simplifies Spooling
Saves Miles of Wire Lines
The Grizzly "No-Wip" Line Saver is a thoroughly engineered device . . . engineered to do a specific job, to be trouble free, to minimize wear and breakage of wire lines. It is simple, safe, perfectly balanced, and easily installed. It will pay dividends every year in wire lines saved. Ask your supply house or write for Bulletin No. 10-OF.
E. M. SMITH COMPANY
600-650 S. Clarence St., Los Angeles, Calif., U. S. A.
Complete Stocks Maintained In Our Warehouse at:
407 Velasco Street, Houston, Texas
1621 East Yellowstone, Casper, Wyoming
1008 S. E. Twenty-ninth Street, Oklahoma City, Oklahoma
Export Office:
Continental Emsco Co., 30 Rockefeller Plaza, New York, N. Y.
Distributed by Leading Supply Companies
GRIZZLY
"NO-WIP" LINE SAVER

H. Lee Flood Joins Staff of Petroleum Co-ordinator

H. Lee Flood, associate editor of *The Petroleum Engineer* since January, 1939, has accepted the post of petroleum production analyst in the Office of Petroleum Coördinator for National Defense at Washington, D. C. The appointment was effective January 1.

H. LEE FLOOD

Prior to joining the staff of *The Petroleum Engineer*, Flood was an engineer with the Natural Gas Pipeline Company of America, Chicago, Illinois. Other connections in the industry were with the Empire Oil and Refining Company, Shell Petroleum Corporation, Marland Oil Company of Oklahoma, Marland Oil Company of California, and the Empire Companies.

Flood was born in Ponca City, Oklahoma, in 1907 and attended public and high school in that city. A degree in engineering was received from Stanford University in 1930.

H. B. Kellogg Heads Seaside Oil Company

At a special meeting of the Board of Directors of the Seaside Oil Company, Santa Barbara, California, H. B. Kellogg was elected president and general manager of the company, and F. E. McClaren, vice-president and sales manager.

Kellogg succeeds to the office vacated by the recent death of M. W. O'Brien. He has been vice-president of the Seaside Oil Company since September, 1936, and a director since February, 1937. Kellogg has been associated with the petroleum industry for more than 25 years.

McClaren's election to the vice-presidency climaxes a spectacular rise with the company. Entering the organization as assistant sales manager in July, 1936, he was made sales manager in February, 1937. In November of the same year, he was made a director.

E. E. DeBack Passes Away

E. E. DeBack, Corpus Christi, Texas, oil company executive, died on January 1 from a heart attack. He was 42 years of age.

DeBack was vice-president of the Stratton Pipe Line Company, and general superintendent of the Coastal Recycling Corporation, the Chicago Corporation, and the Gulf Plains Corporation, affiliated organizations. Previous affiliations in the industry were with the Pan American Petroleum Company, Foster Wheeler Corporation, and the Hercules Gasoline Company, Inc.

E. E. DeBACK

He was president of the American Recycling Association, and when that body was consolidated with the Natural Gasoline Association of America last September, he was elected vice-president in charge of the new high-pressure gas division, a post he held at the time of his death.

DeBack was born in Watsonville, California, and received an A.B. degree in engineering from Stanford University in 1921. An M.S. degree in engineering was received from Massachusetts Institute of Technology in 1922.

He is survived by his widow, a daughter, his parents, and a sister.

Illinois Mineral Industries Conference Dates Announced

Dr. M. M. Leighton, chief of the Illinois State Geological Survey, announces that the 1942 Illinois Mineral Industries Conference will be held at Urbana, Illinois, on October 30 and 31.

Separate sessions will be devoted to discussions of researches and problems involving the state's coal industry, oil and gas exploration and development, the clay and clay products industry, and the rock and rock products industry, including fluorspar.

In view of the uncertainties engendered by the fact that the country is involved in war, the general theme of the conference will be determined at a later date, in order that it may be of the utmost timeliness and interest.

The conference will be sponsored jointly by the Illinois State Geological Survey, which is a division of the State Department of Registration and Education, the Engineering Experiment Station of the University of Illinois, and the Illinois Mineral Industries Committee. National professional societies, trade associations, scientific research organizations, and leading educational institutions will coöperate in sponsoring this conference, and will be represented by delegates.

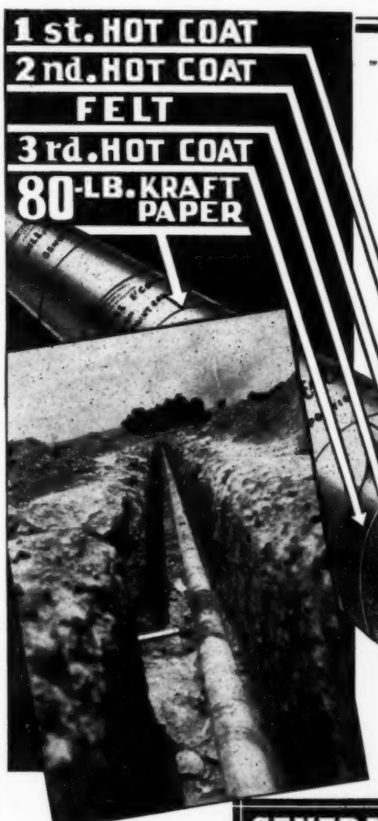
Waiting Time During Black-Out Not "Hours Worked"

Time spent by employees on the premises of an employer covered by the Wage and Hour Law during black-outs or air-raid alarms where no work is done need not be compensated for as "hours worked," Acting Administrator Baird Snyder, Wage and Hour Division, U. S. Department of Labor, has declared. Several inquiries on this point had been received by Snyder.

Let's Dissect

and see what the

HILL-HUBBELL PROCESS OF PROTECTION IS • •



An installation of 4½-inch O.D. HILL-HUBBELL protected STEEL PIPE at Gadsden, Alabama.

- Clean STEEL PIPE is processed at the mill, under the same roof, by the HILL-HUBBELL factory method. This includes mechanical agitation and electromatic temperature control.

Constantly increasing demand for HILL-HUBBELL factory processed STEEL PIPE is due to the THOROUGH PROTECTION this modern method gives.

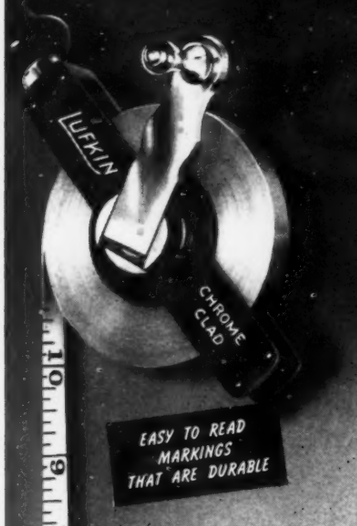
Write TODAY for your copy of "THE BOOK OF PIPE PROTECTION" which describes our process in detail.

BUY STEEL PIPE AT ANY OF THESE MILLS

Jones and Laughlin Steel Corp.
National Tube Company
Republic Steel Corp.
Spang Chalfant, Inc.
The Youngstown Sheet and Tube Company

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE, SAN FRANCISCO, CALIFORNIA, U. S. A. •

LUFKIN
OIL GAGING STEEL TAPES



A gaging tape to perfectly fit your needs can easily be selected from the many different patterns that Lufkin offers you. Illustrated here is the No. C1280 tape with the new Chrome Clad line. Its jet black markings are easy to read against the satin chrome surface that won't rust, crack, chip or peel. The six ounce bob No. 588 is solid brass. Write for free Catalog No. 12 and see the tapes at your supply store.

LUFKIN
SAGINAW, MICHIGAN • New York City
TAPES · RULES · PRECISION TOOLS

Meter Company Gives Christmas Party

The annual Christmas Party for the kiddies of employees was held on December 22 in the Pittsburgh Equitable Meter Company's main factory at Pittsburgh, Pennsylvania. Community singing preceded the arrival of Santa Claus who distributed valuable gifts to each child in attendance. Short talks were given by Colonel W. F. Rockwell, president, and Captain A. E. Higgins, general sales manager. Occupying the center of the platform in the picture is Carl Dixon, shop superintendent, who served as master of ceremonies. Colonel Rockwell is seated on the edge of the platform in the foreground with two of his seven grandchildren.

Silver Anniversary for Key Company

December 15 marked the 25th anniversary of Key Company, East St. Louis, Illinois, and it was observed by a series of conferences attended by all district representatives and department heads, and concluded with a banquet on December 18 at Missouri Athletic Club in St. Louis.

R. L. Dutton has been president of the company since its founding, and the late Fred E. Key, co-founder, was vice-president in charge of production until the time of his death.

The company's original product was a one-piece hand-hole closure cap for water tube boilers, and more than 6,000,000 of these caps were produced in the course of the company's history. The Key Hand Hole Cap was also adapted as a closure plug for the old Burton oil stills, and with the advent of high-pressure tube stills Key Company originated and developed a line of return bend fittings adapted for severe operating conditions.

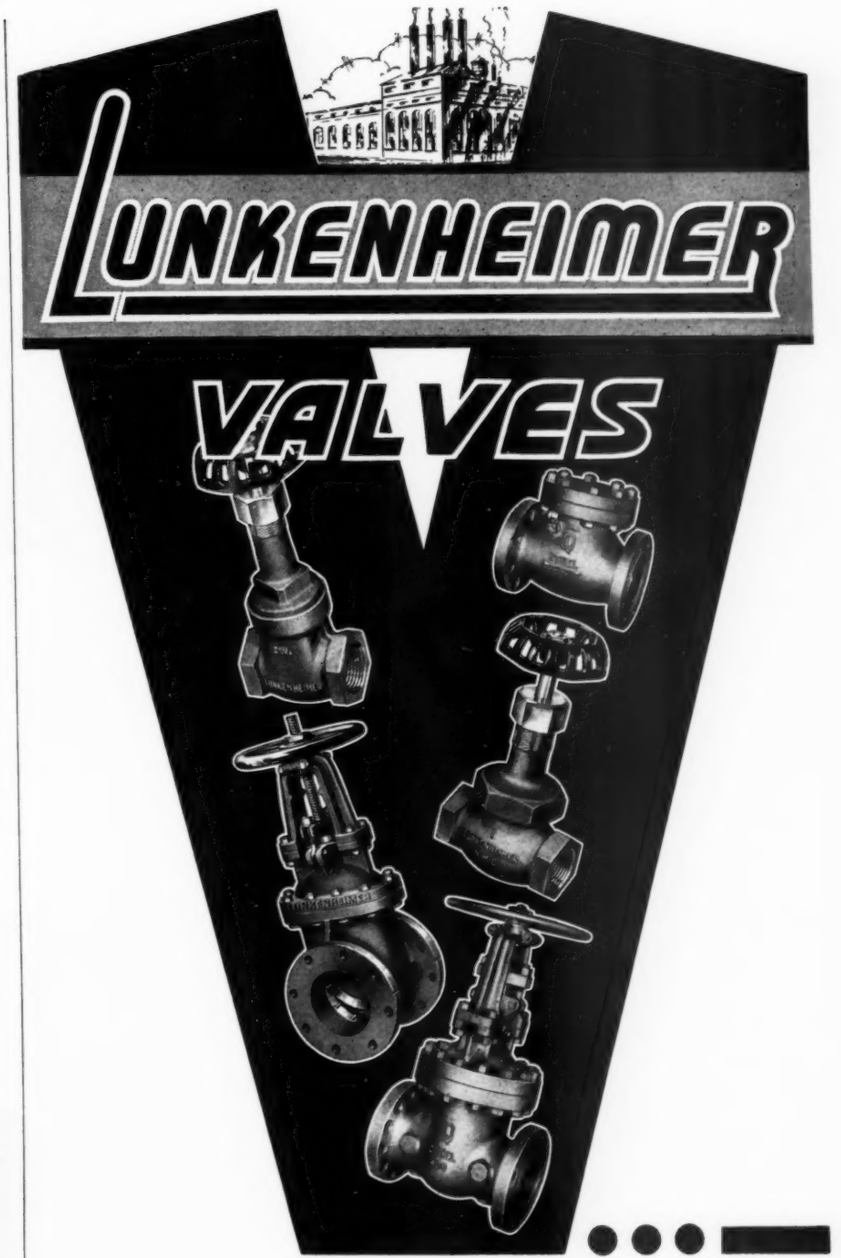
In the picture (opposite page) R. L. Dutton, president, examines a commemorative plaque designed by M. B. Crowe, Tulsa, Oklahoma, representative of the company. With Dutton are Bernard Gross, sales manager, and Merle Burkhart, chief engineer.

Arch Campbell Manager Sales Superior Engine

Arch F. Campbell has been appointed manager of sales by The National Supply Company of its Superior Engine Division, to succeed the late

ARCH F. CAMPBELL

Fred R. Lowell. Prior to his appointment, Campbell was branch manager at Tulsa, Oklahoma, for the Waukesha Motor Company. George A. Duncan, formerly assistant to Campbell, succeeds his as branch manager for the Mid-Continent Division of Waukesha.



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NATIONAL DEFENSE

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT. 318-322 HUDSON ST. NEW YORK

EACH IS SAND-BANUM

"The Entirely Different Boiler and Engine Treatment"

Remove and Prevent boiler scale and corrosion with SAND-BANUM. It's the safe, certain and convenient way ... and so economical.

• • • • •

SAND-BANUM SPECIAL

The simple, safe and certain method of keeping **DIESELS** and other radiator cooling systems free from scale and rust.

SAND-BANUM SPECIAL

• • • • •

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza
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Stocks carried by
WESTERN SAND-BANUM COMPANY
Houston, Texas **Fresno, California**
and at other convenient points including leading supply houses

•

Export Representatives
PETROLEUM MACHINERY CORP.
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Allis-Chalmers Elects New Board Chairman and President

At a meeting of the board of directors of Allis-Chalmers Manufacturing Company, held in Milwaukee, Wisconsin, Max W. Babb, president of the company, was elected chairman of the board, and W. C. Buchanan, a director and member of the executive committee, was elected to succeed him as company president.

Buchanan has for the last six years devoted a substantial portion of his time to the Globe Steel Tubes Company in Milwaukee, of which he is president, and in which capacity he will continue.

Babb in becoming chairman of the Board will fill the position formerly occupied by the late General Otto H. Falk, which has been vacant since his death in 1940.

Barrett Consolidated with Parent Company

The Barrett Company, New York, New York, has been consolidated with its parent company, Allied Chemical and Dye Corporation, and hereafter its business will be conducted as The Barrett Division, Allied Chemical and Dye Corporation. All contracts will be performed by the successor company, it is announced, and except for the change in name, operations will be conducted as heretofore by the same personnel.

J. E. Holmes Assistant Manager Tubular Sales for Youngstown

The Youngstown Sheet and Tube Company announces the appointment of James E. Holmes as assistant manager of tubular sales with headquarters at Youngstown, Ohio. Holmes was formerly associated with the Republic Steel Corporation in Cleveland, Ohio.

F. R. Staley in Mid-Continent

F. R. Staley, sales and research engineer, Magnesol Company, New York City, a division of Westraco Chlorine Company, was a recent business visitor in the Mid-Continent area.

Chemistry to Play Important Role in War

"If the war turns out to be a long one, the National Chemical Exposition, scheduled for November 17, 18,

How often has it been said "A chain is no stronger than its weakest link." Similarly, a country cannot grow stronger than its weakest subjects ... thank God that here in America we are united as never before to stand as one ... to make every link of our *National life chain* stronger than ever before.

We all know that we will be called upon for extreme sacrifices ... we stand ready to accept whatever burden the fruits of victory will surely bring ... are willing to pay the price of preserving for us and our posterity the American Way of Life now being attacked. May the New Year bring a quick decisive victory with lasting Peace echoing thoughout the universe ...

"Peace on Earth—Good Will Toward Men"

★

ALABAMA
Hotel Admiral Semmes ..... Mobile
Hotel Thomas Jefferson ..... Birmingham

DISTRICT OF COLUMBIA
Hotel Washington ..... Washington

ILLINOIS
Hotel Faust ..... Rockford

LOUISIANA
Jung Hotel ..... New Orleans
Hotel DeSoto ..... New Orleans

MISSISSIPPI
Hotel Lamar ..... Meridian

NEBRASKA
Hotel Paxton ..... Omaha

NEW MEXICO
Hotel Clovis ..... Clovis

OKLAHOMA
Oklahoma Biltmore ..... Oklahoma City
Hotel Aldridge ..... Wewoka

SOUTH CAROLINA
Hotel Wade Hampton ..... Columbia

TEXAS
Hotel Alice ..... Alice
Hotel Stephen F. Austin ..... Austin
Hotel Settles ..... Big Spring
Hotel Brownwood ..... Brownwood
Hotel Southern ..... Brownwood
Hotel Laguna ..... Cisco
Hotel Cortez ..... El Paso
Hotel Texas ..... Fort Worth
Hotel Buccaneer ..... Galveston
Hotel Galvez ..... Galveston
Hotel Jean LaFitte ..... Galveston
Coronado Courts ..... Galveston
Jack Tar Court ..... Galveston
Miramar Court ..... Galveston
Hotel Cavalier ..... Galveston
Hotel Plaza ..... Laredo
Hotel Lubbock ..... Lubbock
Hotel Falls ..... Marlin
Hotel Cactus ..... San Angelo
Angeles Courts ..... San Antonio

VIRGINIA
Mountain Lake Hotel ..... Mountain Lake

★ ★ ★

Affiliated NATIONAL HOTELS
HOST TO THE NATION
SERVING 10 STATES AND OUR NATION'S CAPITAL

19, 20, 21, and 22, at the Stevens Hotel, Chicago, Illinois, expects to play an important part in winning it," says Victor Conquest, chairman of the Exposition Committee of the Chicago Section of the American Chemical Society. "It is generally conceded that the winner in this war will be the country that can advance the fastest technically, with its methods, materials, and machines."

The National Chemical Exposition and the National Industrial Chemical Conference will bring together an audience from almost every state in the union, with urgent problems to solve.

Committees Appointed for A.P.I. Meeting at Pittsburgh

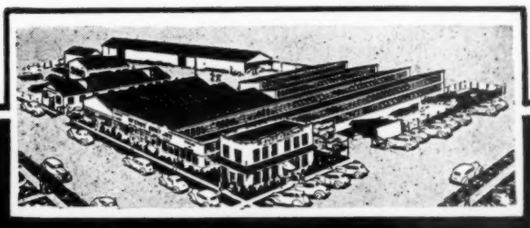
Chairmen and members of four committees have been appointed to plan and carry out arrangements for the spring meeting of the Eastern District of the American Petroleum Institute's Division of Production to be held April 9 and 10, 1942, in the William Penn Hotel at Pittsburgh, Pennsylvania. They are as follows:

Arrangements and Entertainment—Chairman, J. V. Goodman, Equitable Gas Company, Pittsburgh; Hugh R. Brankstone, Gulf Oil Corporation, Pittsburgh; Otis Cole, South Penn Oil Company, Pittsburgh; R. J. Plank, Peoples Natural Gas Company, Pittsburgh; A. C. Simmons, Simmons Oil Corporation, Bradford, Pennsylvania, and S. M. Vockel, Waverly Oil Works Company, Pittsburgh.

Program—Chairman, M. G. Gulley, Gulf Oil Corporation, Pittsburgh; J. C. Askam, The Ohio Oil Company, Findlay, Ohio; F. E. Eckert, Hanley and Bird, Bradford; M. R. Joy, Cities Service Oil Company, Mount Pleasant, Michigan; R. J. Sullivan, The Carter Oil Company, Mattoon, Illinois, and John A. Thompson, Belmont Quadrangle Drilling Corporation, Bradford.

Registration—Chairman, V. F. Bowyer, Peoples Natural Gas Company, Pittsburgh; Paul L. Kessel, Carnegie Natural Gas Company, Pittsburgh, and Carroll Mershon, Manufacturers Light and Heat Company, Pittsburgh.

Publicity—Chairman, W. E. Ferguson, Ohio Fuel Gas Company, Columbus, Ohio; R. E. Damp, The Carter Oil Company, Mattoon; I. W. Hartman, Gordon Oil Company, Mount Pleasant; J. E. Schaefer, East Ohio Gas Company, Cleveland, Ohio; E. O. Schillhahn, Manufacturers Light and Heat Company, Pittsburgh, and H. A. Wallace, Jr., United Fuel Gas Company, Charleston, West Virginia.



McEVOY

COMPANY

"OIL WELL EQUIPMENT" SINCE 1906

TEXAS AT MILBY • HOUSTON, TEXAS • TELEPHONE C-2288

SEE McEVOY'S 20 PAGE SECTION IN YOUR COMPOSITE CATALOG

CHRISTMAS TREES
COUNTER HYDROSTATIC GAS LIFTS
SCREENS
PACKERS • SET SHOES

Renew Your Subcription Promptly

Look for the Arm and Hammer

ARMSTRONG BROS.

STUB END WRENCHES

These extra heavy, ruggedly designed Chrome Vanadium Steel Wrenches take long tubular slip-over handles, stand up to long leverage... tighten screws, bolts and nuts far tighter or loosen them even when badly corroded. These are ideal wrenches around rigs, pipe lines and for general heavy duty work. Three types (from 1¼" to 3½") with long, slip-over tubular steel handles, each of which fits several sizes.

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
331 N. Francisco Ave., Chicago, U. S. A.

STOP NEEDLESS FIRES

...protect workers

Open-top cans of inflammable liquids or ordinary taps are a hazard. Protectoseal *safety* cans and bungs help end careless handling and storing of inflammables. Widely used in vital defense industries. Many models to choose from.

When fires do occur, be ready on an instant's notice to protect lives. Bullard Fire Blankets mount like fire extinguishers...out of way...snuff clothing fires immediately. Ask for complete descriptive folder.

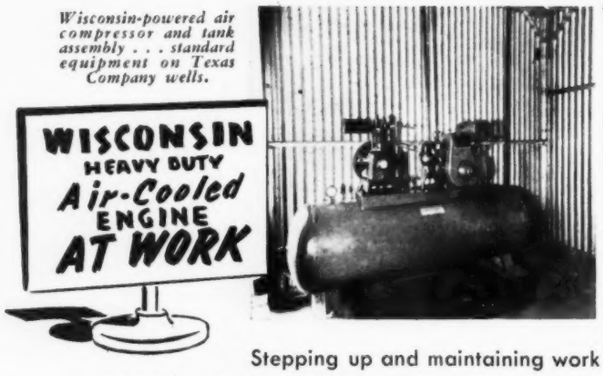
1-B-1

E. D. BULLARD CO.
275 Eighth St., San Francisco

Everything BULLARD in Safety

NATIONWIDE SALES AND STOCKS

Wisconsin-powered air compressor and tank assembly . . . standard equipment on Texas Company wells.



Stepping up and maintaining work schedules during these days of high pressure production in all lines, requires equipment of maximum dependability and efficiency.

Because Wisconsin Engines (1 to 35 hp.) are built for *heavy-duty* service; because they are *air-cooled*; compact in design; extremely light in weight; equipped with weather-sealed outside magneto with impulse coupling for quick-starting in any weather . . . Wisconsin Engines AT WORK today, are increasing productive capacity wherever they are in use.

Write to HARLEY SALES CO., 510 Atlas Bldg., Tulsa, Oklahoma, or M & M Bldg., Houston, Texas—*Oil Field Distributors for Wisconsin Engines and All Types of Utility Units.*

MOST POWER per POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

For
OIL
and
GAS

under High Pressure

You can handle pressures up to two thousand pounds under perfect control and pass on to your distributing lines whatever reduced pressure may be called for by use of the proper C-F Regulators. There are standard regulators for all pressures up to 600 pounds — for higher pressures designs are adapted to suit specifications.

The CHAPLIN-FULTON MFG. CO.

38 PENN AVENUE PITTSBURGH, PA.

TRADE LITERATURE

What to Write For

UNDER THE TITLE, "The Guide to Successful Completions," B and W, Inc., of Houston, Texas, and Long Beach, California, have published an 8-page bulletin, consisting principally of an article reprint, "Casing Movement While Cementing," by Bruce Barkis and Kenneth Wright. The bulletin contains a detailed description of the efficacy of wall-cleaning guides in removing mud filter cake from the wall of the hole, thus assuring good formation-cement contact.

FOR FULL INFORMATION on the Martin Plunger, address John N. Martin, Manufacturer, 11 West Brady Street, Tulsa, Oklahoma, for a copy of their illustrated catalog.

"THE BOOK OF PIPE PROTECTION," released by General Paint Corporation, Hill, Hubbell and Company Division, Cleveland, Ohio, describes the company's process of protection in detail. Copies will be sent on request.

DESCRIPTIVE LITERATURE on Cycoil air and gas cleaners may be obtained from the American Air Filter Company, Inc., 383 Central Avenue, Louisville, Kentucky.

BANTAM BEARINGS CORPORATION, South Bend, Indiana, will release without obligation, copies of their Bulletin P-104 containing details on the company's compact, high-capacity Quill Bearing.

BULLETIN 1079, published by Waukesha Motor Company, Waukesha, Wisconsin, gives a complete, ready-reference list of every Waukesha Power Unit with ratings—speed, torque, horsepower, and size. A copy will be mailed without obligation on request.

THE WALL-COLMONOY CORPORATION, Sixth Floor, Buhl Building, Detroit, Michigan, will send copies of their catalog describing hard facing of wearing parts with Colmonoy, without obligation to the writer.

TUBE-TURNS, INC., Louisville, Kentucky, will send on request their engineering data book and catalog. The catalog contains vital engineering data that explain the advantages and better service with Tube-Turn Welding Fittings, according to the manufacturer.

WICKWIRE SPENCER STEEL COMPANY, 500 Fifth Avenue, New York, New York, will send on request their manual on the selection, application, and usage of wire rope, "Know Your Ropes."

E. M. SMITH COMPANY, 600-650 South Clarence Street, Los Angeles, California, has issued Bulletin No. 10-OF containing a description of the engineering features of the Grizzly "No-Wip" Line Saver.

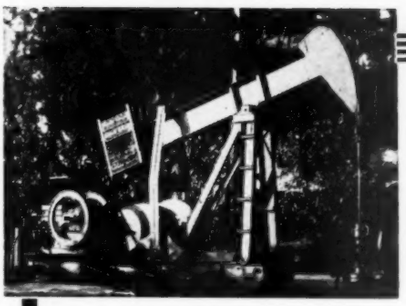
A REQUEST ON YOUR COMPANY LETTERHEAD will bring, without charge, the 55-page book "Welding Procedures" with detailed information on processes for welding particular metals. Address Air Reduction Sales Company, Inc., 60 East 42nd Street, New York, New York.

OIL WELL SUPPLY COMPANY, Dallas, Texas, has released 5 descriptive bulletins on equipment that forms a part of the company's extensive line of surface pumping machinery. The bulletins, which cover the following items of equipment, will be sent on request without obligation: TC-5A, Twin-Crank Pumping Unit; TC-5H and TC-8, Twin-Crank Pumping Units; SC-12A and SC-17A Single-Crank Pumping Units; No. 5 Pumping Jack; No. 101 Swivel; TC-12C and TC-17L, Twin-Crank Pumping Units.

Reed Roller Bit Warehouse Moved to Wichita Falls

Reed Roller Bit Company has moved its warehouse from the K.M.A. field to 700 Virginia Street, Wichita Falls, Texas.

The new, modernistic front warehouse is better equipped to serve the K.M.A. field and surrounding territory, and is manned by the same personnel that has served that area in the past.



Any producer's most deadly weapon against waste—the Model D JENSEN Pumping Unit.

MAKE WAR ON WASTE!

It is good business and sound patriotism to look around for ways and means to cut expenses and eliminate waste.

We have looked through the eyes of producers for 23 years. We know that any well—and this includes YOUR wells—can be more profitable, more efficient and more dependable when equipped with a JENSEN Unit.

Why not investigate? See your JENSEN dealer or write, wire or phone us at Coffeyville.

JENSEN BROTHERS MANUFACTURING COMPANY

. . . . . *Coffeyville, Kansas, U. S. A.*

EXPORT OFFICE: 50 CHURCH STREET, NEW YORK CITY

Good Carburetion —AN ESSENTIAL

Speaking of essentials—good carburetion is vitally necessary for continuous dependable engine performance. Building good carburetion equipment is our business.

Essentially, internal combustion engines provide the most valuable source of power—the kind of power that will win a mechanized war. Drilling wells, pumping the crude, refining and transporting the finished product—high test gasoline utilized in a thousand defense needs.

Maximum engine performance depends upon the accurate control and proportioning of gas-air mixtures. This is the principal function of ENSIGN Fuel Regulators and Gas Carburetors.

Constant research and testing results in the development and application of new and improved principles—those features you enjoy in today's carburetion.

ENSIGN CARBURETOR CO., LTD.

HUNTINGTON PARK, CALIF. • DALLAS, TEXAS • CHICAGO, ILL.

"TOLEDO"

TRADE-MARK REGISTERED U.S. PAT. OFFICE

EASY OPERATING, FAST, EFFICIENT
STOCKS AND DIES
PIPE CUTTERS
POWER DRIVES
POWER PIPE MACHINES
PIPE REAMERS
PIPE VISES
VISE MOUNTS

ORDER FROM YOUR LOCAL DISTRIBUTOR

THE TOLEDO PIPE THREADING MACHINE CO. TOLEDO, OHIO

NEW YORK OFFICE, 502 NO. 2 RECTOR STREET BUILDING

For a Fresh Start STOP at a HOTEL

AMERICAN HOTEL ASSOCIATION
AHA

More than 5000 hotels on the continent and in nearby territories, representing the seventh largest industry, allied for service and progress

AMERICAN HOTEL ASSOCIATION

A Complete Instrument Service

CONSULTING
CONSTRUCTION
MAINTENANCE

INSTRUMENTS INCORPORATED
A Service Organization
DALLAS

FOR REAL PROTECTION AT VITAL FASTENINGS ON PETROLEUM EQUIPMENT

Every Elastic Stop Nut has a resilient non-metallic collar which locks it to the bolt by eliminating all thread play. Available in all types and sizes.

SOLD BY LEADING SUPPLY HOUSES
FACTORY STOCKS IN HOUSTON AND LOS ANGELES

» Write for folder explaining the Elastic Stop principle

ELASTIC STOP NUT CORPORATION
2365 VAUXHALL ROAD • UNION, NEW JERSEY

Elastic Stop SELF-LOCKING NUTS

Book Reviews

Pipes and Valves for Gas, Air, Water, and Steam, by E. Molloy. Published by The Chemical Publishing Company, Inc., 234 King St., Brooklyn, New York. 96 pp. Price $2.00.

A book intended for installation engineers and erectors in the engineering and allied industries, it deals with the installation of pipes in connection with steam, water, and gas systems, sections being included on the use of the various accessories such as valves and couplings, and also on the use of the necessary tools for carrying out the work. Chapters include barrel piping, cast piping, valves, and steel pipe installation. A useful feature of this book is the tables of pipe data.

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Stratigraphic Type Oil Fields, edited by A. I. Levorsen of Tulsa, Oklahoma, chairman of The American Association of Petroleum Geologists, assisted by 4 nationally known geologists; published by The American Association of Petroleum Geologists, Tulsa, Oklahoma. 900 pp. Price $5.50.

This book is a symposium of 37 papers by 52 authors. It is intended as a factual background on which a further approach may be made to the causes of oil and gas accumulation and also as a basis for the reasoning necessary to future oilfield discovery.

Among the 300 illustrations are included 5 folded sheets in a pocket in the cover of the book. The 227 references are in an annotated bibliography.

A Dramatic Answer to Japan's Attack

Within a few hours after Japan's bombing, the first heavy 60-ton tank was delivered to the United States Army by the Baldwin Locomotive Works of Philadelphia, Pennsylvania.

Army congratulates Baldwin's on production of first 60-ton heavy tank. Wm. H. Harman, vice-president in charge of sales, The Baldwin Locomotive Works, shakes hands with Brigadier General G. M. Barnes, assistant chief of industrial service, U. S. Army Ordnance, while Lt. Col. D. N. Hausman, chief of Philadelphia Ordnance District, looks on with a smile

At the company's 100-acre proving grounds, the huge monster was put through its paces, astonishing military experts by its maneuverability, precision, and power. Snapping telegraph poles like match sticks from a standing start, engaging in a mock battle with sputtering guns against smaller tanks, and crushing to smoking bits an army "jeep" car were a few of the outstanding performances of this newest answer of America to a ruthless attack.

MEETINGS

California Natural Gasoline Association, Monthly Meeting—February 5, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers, Petroleum Division, Annual Meeting—February 9, 10, 11, and 12, Engineers Building, New York, New York.

Liquefied Petroleum Gas Association, Annual Convention—February 23, 24, and 25, Kansas City, Missouri.

American Petroleum Institute, Division of Production, Southwestern District, Spring Meeting—February 26 and 27, Adolphus Hotel, Dallas, Texas.

North Texas Oil and Gas Association—February 28, Wichita Falls, Texas.

American Society for Testing Materials, Committee Week and Spring Meeting—March 2, 3, 4, and 5, Cleveland, Ohio.

Indiana Independent Petroleum Association, Spring Convention and Refiners' and Suppliers' Exhibit—March 3, 4, and 5, Hotel Severin, Indianapolis, Indiana.

American Petroleum Institute, Division of Production, Pacific Coast District, Spring Meeting—March 10, Biltmore Hotel, Los Angeles, California.

Wisconsin Petroleum Association, Annual Convention and Equipment Show—March 18, 19, and 20, Schroeder Hotel, Milwaukee, Wisconsin.

American Society of Mechanical Engineers, Spring Meeting—March 23, 24, and 25, Houston, Texas.

American Petroleum Institute, Division of Production, Mid-Continent District, Spring Meeting—March 26 and 27, Mayo Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Division of Production, Eastern District, Spring Meeting—April 9 and 10, William Penn Hotel, Pittsburgh, Pennsylvania.

American Institute of Mining and Metallurgical Engineers—April 15, 16, and 17, Cincinnati, Ohio.

National Petroleum Association, Thirty-ninth Semi-Annual Meeting—April 16 and 17, Hotel Cleveland, Cleveland, Ohio.

Southwestern Gas Measurement Short Course—April 21, 22, and 23, University of Oklahoma, Norman, Oklahoma.

American Association of Petroleum Geologists, Twenty-seventh Annual Meeting—April 21, 22, 23, and 24, Cosmopolitan Hotel, Denver, Colorado.

Petroleum Industry Electrical Association—April 22, 23, and 24, Shreveport, Louisiana.

American Gas Association, Natural Gas Section, Annual Convention—May 4, 5, 6, and 7, New Orleans, Louisiana.

Natural Gasoline Association of America—May 13, 14, and 15, Mayo Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Mid-Year Meeting—May 25, 26, 27, 28, and 29, Oklahoma City, Oklahoma.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 8, 9, 10, and 11, Cleveland, Ohio.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, Rochester, New York.

Illinois Mineral Industries Conference—October 30 and 31, Urbana, Illinois.

American Petroleum Institute, Annual Meeting—November 9, 10, 11, 12, and 13, Chicago, Illinois.

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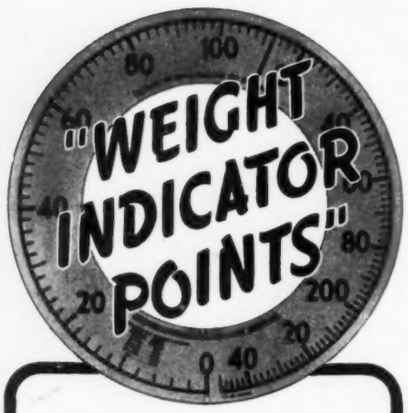

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